ANNALS of the
Association of American Geographers

VOLUME XLI SEPTEMBER, 1951 NUMBER 3

FOUR PAPERS BY THE LATE RALPH H. BROWN

NOTE BY THE EDITOR

THE writings of the late Ralph H. Brown in historical geography of the United States are among the notable contributions to American geography. His many articles, as well as his two major works, *Mirror for Americans* and *Historical Geography of the United States,* demonstrate his concept of historical geography with eminent clarity and with scholarly regard for the origins of that concept. He observed existing geographic facts and he searched historical records. From the interplay between these two methods, he brought into focus the geographic beliefs of the past and he reconstructed parts of the geography of the past. Out of both of these the geography of the present has evolved. Aside from the fundamental geographic nature of his work, his writing was so magnificently clear that it carried his thoughts far beyond the strictly geographical audience, particularly into the realm which historians and geographers have in common.

Only four segments of his work remain in manuscript form. They are here reproduced for the contribution which they make both singly and collectively. The first three sections are early versions of chapters in a book which later developed into *Mirror for Americans.* Despite certain obvious similarities between these three chapters and parts of the book, the present articles clarify still further certain elements of the historical geography of the United States. The fourth section is a brief note written to accompany a discovery made during manuscript search, and the discovery itself. As an indication of American thought concerning geography, this discovery, a century-old statement by an appreciative non-professional, is particularly apt in this present period. All four segments are a fine, added contribution to American geographic writing.

I

A LETTER TO THE REVEREND JEDIDIAH MORSE AUTHOR OF THE AMERICAN UNIVERSAL GEOGRAPHY

YOUR books, especially the *American Universal Geography,* have caused an extraordinary amount of letter-writing. During your lifetime you read, doubtless with mixed feelings common to all highly sensitive persons, many printed communications frankly critical of your geographies; thus, to set before the public another which formally considers their contents is to follow an established precedent. St. George Tucker of Virginia, for example, chose the above heading for the pamphlet which he felt impelled to prepare in 1795, six years after the first edition of your description of America. Ostensibly directed to you, the Tucker letter was in reality intended to warn your readers that a section of your book, the one purporting to describe Williamsburg, was woefully inaccurate.

This letter, unlike its predecessors, is written in September, 1938, over a century and a quarter since your works had vogue. At first thought this seems a strange procedure, but it may not be considered wholly inappropriate when it is recalled that, as an author of one of the first "best sellers," you have continued to live in succeeding generations. In contrast to earlier letters which mainly called attention, often not very temperately, to faults of detail, this one is intended as a critique of the larger aspects of your descriptions of America. Your biographers, lacking the background necessary to evaluate your geographical work, have failed to do this for us. Mr. W. Randall Waterman unintentionally misleads his readers in asserting that you prepared your geographies from the best available American and European sources. The same over-charitable assumption colors other short accounts of your life and achievements, accounts notably shorter and less penetrating than those written about your eminent son, the inventor of the telegraph.

An appraisal of your descriptions of this country, as it was during that stage in its development when you beheld it, is no easy matter. Obviously, one can form some estimate by reading what you wrote and comparing it with descriptions of the same area independently written by others during the same period. But, since only a small part of any chapter in the *Universal* is original with you, the appraiser must find the material which you used and scrutinize that for its geographic validity. Not all of it, to be sure, can be found; you indicate only rarely your sources of information, thus forcing us, when it is at all possible, to trace origins mainly through recognition of the form or content of that section or paragraph. This, however, is still insufficient: we must discover not only the material which you admitted but also that which you omitted; only by this procedure can we judge the relative ex-

haustiveness of your searches and the wisdom with which selections were made. It is recognized that this part of the critique must be left uncompleted.

You faced special difficulties in making your compilation. In your time there were no great library collections. Some of the materials bearing upon the geography of the country from 1790 to 1810 you could have seen only in manuscript form, possibly in various stages of preparation on the different authors' desks. It would be an unreasonable critic indeed who would insist on that degree of penetration on your part. Then, too, it is likely that some material, especially the kind not protected in book form—pamphlets, papers, and maps subject to loss or destruction—was readily accessible to you and not to us. Despite these and other barriers or discouragements, it is possible to make some headway toward forming an objective opinion of your work.

To set the stage for this critique, let us see how you had won popular recognition, by 1800, as *the* American geographer and why so many letters were written you.

For a decade, copies of your description of America had been on library tables and bookshelves throughout the smaller United States of that time and in translation in European countries. For sixteen years thousands of school children had plodded through your *Geography Made Easy* and had come to identify the name "Morse" with this subject. It was through these books and their numerous reissues—twenty-five editions of your school text and seven of the *Universal* appeared during your lifetime—that you had achieved this distinction and had been awarded a high degree by the University of Edinburgh. Some of your biographers have designated you as the *first* American geographer. This you would probably be the first to deny, because in your book you graciously admit indebtedness to many earlier American writers and investigators in this field. Nevertheless, you were in the popular fancy the authority on the geography of the United States during the 1790's and 1800's.

This popular recognition led to many of the incoming letters. Some came in response to your own published appeal for geographical information about the United States from anyone who cared to supply it. This group of letters was welcome: their contents presumably found expression in your American geographies which expanded in bulk through the ensuing years. Welcome also were the letters from men and women to whom you transmitted questions addressed to you by other people. To a geographical authority like yourself people then turned as they do now to an encyclopedia. The questions were so varied that many went beyond your own knowledge, and in this dilemma you sought aid from one individual or another whom you considered qualified to make reply. Often the consultee took advantage of the opportunity to expand the answer into a paper or essay which later appeared in one of the several literary magazines then in vogue. We today have no means of knowing how much of this correspondence you attended to personally, but we suspect that between preparing sermons, editing the *Panoplist*, answering sundry questions or transmitting them to others, and composing your voluminous geographies, your time was well occupied.

Less welcome were the letters finding fault with the details of your descriptions of parts of the United States. The many embarrassing moments these none-too-gentle commentaries caused were no doubt partially compensated for by the very considerable income which the books provided. The sting of the carping letters was also occasionally offset by others of a commendatory nature—the very kind which would not be published for others to read. One can now appreciate your gratification in receiving from Dr. Samuel L. Mitchill his laudatory letter of July 4, 1789, even though he did devote much space to suggestions for improvements in the second edition. One good letter from the learned Mitchill, himself something of a geographer, could easily offset a dozen of the other kind.

Comforting also was the realization that a one-volume description of the United States, even the smaller and perhaps simpler United States of your time, to the satisfaction of all readers, was a practical impossibility. Great gaps must be left open at some points and at others much information sketchily and inadequately rendered. Every description of America published since your time, and there have been many of them, has suffered from similar, often unavoidable, faults. Your main calling was the ministry of a Charlestown church; your geographic work was an avocation. You could scarcely devote a lifetime to the preparation of a whole series of thick volumes, as did your contemporary Christoph Ebeling who, with characteristic German thoroughness, wrote 6,500 pages about the United States, a country which he greatly admired but had never visited. And had you done so, the venture would surely have proved financially unprofitable.

Charles P. Daly, a former president of the American Geographical Society, wrote on the flyleaf of one of your books in its extensive library that you were the "father of American geography." Possibly this idea was original with him; on the other hand he may have been recording a statement so oft-repeated as to have become almost an aphorism. In any case it is necessary to observe that the statement is true only to the extent that geography is identified with public school teaching. You also made familiar a certain kind of composition, the kind embodied in your compendiums and still later in your gazetteers. Some have implied that you were the originator of this method which, as you say in the preface, involves the collection and arrangement of a vast variety of widely scattered information concerning the states of the union. We will agree that you succeeded in making the method widely known, but will pass on the question of your originality. Suffice it to say that others prepared similar compilations and gazetteers at about the same time—Joseph Scott, W. Winterbotham, Christoph Ebeling, John Pinkerton, B. Davies, John Walker, and James Mease, to mention a few of the more prominent compilers. With the exception of the scholarly Ebeling, each laid claim, with some show of pride, to a "new system" of geography, superior to all others.

The kind of work which you and the other American writers did won but slight approval from contemporary critics, especially from the critics who were familiar with the traditions of geography. A reviewer in the *American Review and Literary Journal* for 1801 pleads for " a preservation of the grand and acknowledged

division of the sciences," lamenting that "almost all geographical compilers, however, seem to have lost sight of this distinction. Their works are little more than medleys of politics, history, and miscellaneous remarks on the manners, languages, and arts of different nations, arranged in the order in which the territories stand on the map. The facts, strictly geographical, contained in them form but a hundredth part of the whole." According to another writer in the *Monthly Anthology and Boston Review* for 1805, geography could then scarcely aspire to "the dignity of science [as it had done earlier]. It has been deserted by the man of genius, philosophy and taste, as a pursuit where no laurels are to be gathered, or such only as are short in their duration and fading in their verdure."

These observations assume prophetic quality when read in the light of the subsequent fate of your books, for it is here necessary to remark a spectacle uncommon in science. The plain fact is that the works of a presumed authority on the geography of the United States during the 1790's and 1800's have been ignored for a century and never more so than at the present time.

Rarely has a modern scholar, investigating some aspect of the past, solved a crucial point by an apt quotation from Mr. Morse, a neglect made all the more glaring by the innumerable quotations from and citations to other literature of the same period. Other books composed at the same time as yours have achieved sufficient greatness to have warranted their survival, with improvements, down to the present, the two outstanding examples being the dictionary of Mr. Webster and Nathaniel Bowditch's *Practical Navigator.* Still others, for example Patrick Campbell's *Travels in . . . North America in . . . 1791 and 1792,* have been reissued in attractive form with editorial comment within the past few years. Again one finds that the vast majority of present-day geographers have never sought information or guidance from the Morse volumes, and many of this group are amazed to learn that your name has been closely identified with the earlier development of their subject. By contrast, no self-respecting economist neglects a study of John Stuart Mill, every biologist knows his Darwin, and modern geologists revere the names of Agassiz and Gilbert though much that these men did is obsolete or has since been done better by others.

Why this neglect of the Morse geographies? Is it because the books are rare? No; the large editions of your books ensured the present-day survival of many, and copies are to be found in all the larger and probably in most of the city and college libraries in the country. In many a home is a copy of Morse, and dealers in old books have little difficulty in supplying the demand at moderate figures, though your *Geography Made Easy,* as a curiosity, has recently been auctioned at nearly two hundred dollars. Is it because people are disinterested in the past? Again, no. Professional historians, writers of historical novels, bibliographers, antiquarians; indeed, historically-minded people of all groups have constantly culled likely sources for scraps of authentic information bearing upon the earlier days of our country. Possibly the period during which your books appeared has been less intriguing to the professional historian than antecedent or subsequent periods. It was a time of

essential stability between great events, especially marking the interval between the formation of the Union and the second war with Britain. No great drama was then unfolding. Nevertheless, many authors of historical studies presumably would have welcomed the authoritative observations of a geographer who, in his maturity, beheld the growing nation during this interval.

Investigators of the American past have callously ignored your descriptions of America mainly because the material which they contain can be found to better advantage in their original form. Your contribution was limited to the organization of material roughly by states and territories: as you say, you aimed at utility rather than originality. In compiling this miscellany, you resorted to a practice abhorred by scholars—that of borrowing from others without acknowledging the sources. In the preface it is stated that "when [the author] has met with publications suited to his purpose, he has made a free use of them; and he thinks it proper to observe, that, to avoid unnecessary trouble, he has frequently used the words as well as the ideas of the writers, although the reader has not been particularly apprized of it." Unnecessary trouble for whom, Mr. Morse? Certainly this practice imposes an additional burden upon a present-day reader who, before forming an estimate of the validity of your work, must investigate the materials you used. Nor are the results of such a penetration to the available sources at all reassuring; there seems to have been a notable lack of discrimination between the good and the bad, the suitable and the unsuitable.

Let us take for an example, because it is an average chapter, the section entitled Pennsylvania, which is placed between the chapters on New Jersey and Delaware.

The first four pages consider boundaries, civil divisions, and rivers, and give facts which could be shown to good advantage on a map of page size. The description of the "face of the country" which follows is taken in large part from Thomas Jefferson's *Notes on Virginia,* first published in 1784, and in part also from Lewis Evans's *Geographical Essays* (1755). As a staunch supporter of orthodoxy you expurgated much from Evans, both in this chapter and in others, because of his nontheological views of the origin of these features. The succeeding two pages on the climate of the state are largely devoted to proving that it was "more unhealthy than formerly." This was a question about which a controversy raged at the time, with various writers offering various suggestions. A judicious compiler would have presented various facets of the controversy if, indeed, the subject were permitted to intrude into the discussion of the climate as such. There was plenty already to be made known about the state's climate, through the patient labors of Rittenhouse and Rush, and later by M. Legaux.

Nearly all of the seven-page section on population is wasted in the reproduction of the famous "letter from a citizen of Philadelphia to a friend in England," purporting to describe the sequence of settlers occupying a site somewhere in that general area. The letter may be termed famous for, although its original author (doubtless one of speculative mind) is no more positively known than is the area

it is supposed to depict, it caught the fancy of many writers on America at this time and is to be found in complete or modified form in all sorts of places. Follow ten pages on religions, societies, and colleges, an equally full treatment of "chief towns," and a page on "curiosities." The concluding five pages are given over to a discussion of history, a reproduction of the state constitution, and remarks on its administration.

Surely, only a small part of this represents the stock-in-trade of the geographer. Of that small part which is admissible, but little seems to contribute to the understanding of Pennsylvania's geography as it was during the closing years of the eighteenth century. Your information was taken from sources extending over too long a period; not enough of it was strictly contemporaneous with the time of your composition. The greater part of the strictly geographical material was simply not up to date. A similar scrutiny of the sources used in other chapters indicates that, when pieced together as they are in your compilation and those of others, the result could not possibly give the reader the "view of the present situation of the United States" which is promised in the subtitle of the *Universal.*

It is perhaps unfortunate that you did not delay the original issue of your description at least for ten or possibly for fifteen years. By that time two important developments had occurred and of one of these, at any rate, you could have taken some advantage.

One development was that by 1800 or a little later, the resources suitable for use by geographical investigators had increased by leaps and bounds. You started your compendium in 1785, devoting four years to its preparation. This was five years before the first official census of the population; in 1800, of course, there was another of greater accuracy. The country had scarcely settled down after the turmoil of the Revolution and the formation of the Union. Later on, people could devote more time to solid scientific work. During this period two geographically-minded statesmen, Jefferson and Gallatin, prepared significant state papers dealing with productive industries. It was a time also of many travels and published accounts of travels by citizens and foreign visitors, humble or distinguished. Fred L. Pattee, in a recent survey of early American literature, has said that "during the 1790's America swarmed with emigrees from the French Revolution" and that "Talleyrand, Beaumais, Viscomte de Noailles and his brother-in-law Lafayette, Volney, the Duc de Liancourt, and General Moreau . . . were but a few of the distinguished members of the French colony" which gave to Philadelphia the air of a foreign capital. During and following the 1790's and 1800's, literary and scientific periodicals took on new life and others came into being. Some, like the *Columbian,* the *American Museum, The Port Folio,* and *The Medical Repository,* were doomed to a brief existence, but while flourishing their pages were partly filled, perhaps strangely in the case of the medical journal, with geographical material.

Only through the most drastic revisions in the succeeding six editions could you

have taken full advantage of these new resources bearing upon the realities of the geography of America. The making of even moderate revisions in a writing whose general form has become "frozen" is a notoriously difficult procedure. This is perhaps especially true of the compendious type of treatment; its form, in fact, is the very thing which must be preserved. Few readers, for example, would today approve of startling innovations in the construction of the encyclopedia or the dictionary. To preserve the familiar form of the *Universal,* acceptable apparently to a large number of people at the time, we can surmise that you were tempted to alter it as little as possible and to retain, perhaps against your better judgment, many anachronisms. All geographical accounts of developing regions are likely to be out of date by the time they are published, but the lag is presumably greater and more obvious in the miscellaneous compendium. It seems fair to presume, therefore, that had your first compendium been prepared in 1800 or in 1805, it would have been a much more realistic description of your country's geography at that interval in its development than were the revisions of your original work started in 1785.

The other major development during this period was the demonstration by a small group of writers that the mechanical description of America, state by state and topic by topic, was at best an unnecessarily tedious method of acquiring the essential knowledge. These writers showed, at least partially, that large sections of the older inhabited and therefore better known seaboard lands (extending roughly to the head of navigation) were amenable to description. Within the settled part of the country, large areas were seen to possess some kind or kinds of fundamental unity. Thus by 1800 certain regional terms in addition to "seaboard" were a part of the common language and their limits were fairly well comprehended. Examples were the low country ("tidewater" of a later period), upper country, piedmont, New England, and French Canada. Some observed elements of unity in the natural vegetation; others discovered comparable properties over widely extended areas in the climate and in the "lay of the land," or, to employ an older expression, "the face of the country." Some emphasized the continuity of cultural areas superimposed upon or cutting across the natural units. Thus, the distinctive features of Lower Canada and of the deep South's low country were marked by all except the most unobservant traveler.

These publications—they were few in number and did little more than show the way—employed a method so unlike that of the compendium that you could not reasonably have adopted it. You did, however, occasionally refer to regions in your treatments of the various states.

The principal venture in regional description was that of Constantin F. C. Volney who, after three years of study in this country, published in Paris in 1803 *Tableau du Climat et du Sol des Etats Unis d'Amerique,* a two-volume work. This was translated during the following year both in London and in Philadelphia. The American translator was Charles Brockden Brown, by some considered as the first professional novelist in this country. He himself had a passion for geography and

is said to have written a lengthy geographical treatise; never published, his manuscript has resisted discovery since his death in early manhood. No doubt his earlier acquaintance with the author and his interest in the contents of the work led him to undertake what proved to be an unprofitable task. Volney's *Tableau* has suffered unduly at the hands of writers inexpert in geography because they have assumed, without investigation, that it was just another superficial "travel book." Typical is the remark of David L. Clark, a biographer of Brockden Brown, saying that "the work is a notable example of the vast number of books of travel in America by Europeans who had ill-digested their hastily-gathered information." Hastily gathered indeed! Mr. Clark is here the victim of a conclusion reached all too hastily.

No doubt, Mr. Morse, you knew, or at least knew of, the distinguished Volney, for he took special pains to interview all the authorities on the geography of this country. We suspect, however, inasmuch as Volney was an atheist (at least by reputation) and a free-thinker in many ways—the personification, perhaps, of the "French influence" which dismayed you so greatly—that he found little favor with you. Others, at least, shunned him; Washington, it is said, gave him a half-hearted letter of introduction to carry with him during his studies. It was Volney's intention, upon completion of his preparatory work, to "put into suitable style" the main features of the geography of this country. By this expression he obliquely refers to the desirability of following a style other than that of the compendium, and provides another instance of the personal vanity which so many of his acquaintances in this country disliked. Among his vanities was the belief that he possessed special talent in scientific composition. His goal, however, was never reached. On his return to France to enter the conservative senate he had time only to complete "that part . . . which may be detached without injury or mutilation from the whole performance." His book, then, is simply a part, and possibly not the best part, of the entire description.

To what extent were you acquainted with John Drayton, governor of South Carolina for two terms and author of the treatise entitled *A View of South Carolina as Respects Her Natural and Civil Concerns?* This quasi-regional work was published in Charleston in 1802, the same year during which, with the aid of the Reverend Elijah Parish, you offered *A New Gazetteer of the Eastern Continent.* Drayton was laying the foundation for his work while your *American Gazetteer,* a degenerative form of the *Universal,* was absorbing your attention. Judging from the tone of the preface which Drayton penned in the manuscript of this book in 1821 he was, in contrast to Volney, a man of modest, perhaps retiring, nature and thus less likely to be so well known. In this preface, Drayton writes in retrospect that his book was prepared for the purpose of recording important facts bearing upon his state, not for the purpose "of coming forward as an Author." Of the 500 copies printed, seventy were presented to friends in Europe and in the United States; "the remainder very little more than reimbursed the expenses attending the publication." The map which accompanies the book appears to have been the first one produced in this country upon which geographic regions are outlined.

Drayton's *View*, like Volney's *Tableau*, appeared too late for you to have made much use of it.

Was Dr. Benjamin S. Barton of the University of Pennsylvania one of the "men of Science" with whom you "maintained an extensive correspondence" as part of your preparatory work? If so you were fortunate indeed, because Barton had much sound geographic knowledge to contribute. He was especially able as a critic and editor and maintained throughout a notably sane and unbiased viewpoint with regard to many geographical problems. He it was whom John Pinkerton invited to write the section on the geography of the United States for his compendium.

In fact, we would have reason for more confidence in your chapters on the separate states if you had recorded the names of the men to whom you submitted your manuscripts "for their correction." You neglect to specify the men who, in this indirect way, placed their stamp of approval on the completed *Universal.* If this group included men of the calibre and geographic interests of Barton, Mitchill, Drayton, Samuel Williams, Nathaniel Bowditch, Edward A. Holyoke, Thomas Jefferson, Samuel Holland, Albert Gallatin, Abraham Bradley, and Benjamin H. Latrobe, there would be more reason to look favorably upon the volume as a whole. Acknowledgment is made to Ebenezer Hazard for the use of his historical papers, to Joseph Purcell of Charleston who prepared the map of the southern states for your book, and to Thomas Hutchins, geographer-general of the United States "for his particular friendship and assistance."

In your later years, particularly as secretary for the Society for the Propagation of the Gospel, you became interested in the American Indian. This interest culminated in your tour in 1820, accompanied by your son, through the northern states as far west as Green Bay, a journey which formed the principal basis for your *Report on Indian Affairs* two years later. This writing appears to be your most interesting and original contribution to science. Did this interest in the aborigine bring you into contact with the Indian agents of a few years earlier? There was, for example, Benjamin Hawkins who was agent for the Creek Nation during the closing years of the eighteenth century. His knowledge of the Creek country of lower Georgia, Alabama, and Florida was intimate and detailed, and he left a record telling of an aboriginal life at that time almost unaltered, as it was elsewhere, by contact with white civilization. His poorly organized but detailed report, written apparently in 1799, was not published for another half-century, thus providing another example of a record contemporary with the period about which you were writing, a source probably inaccessible to you but available to us.

No reasonable person should expect that a geography of the United States written a century and a quarter ago would be acceptable to us today. A wisdom more than human would have been required for you or your contemporaries to have anticipated our needs or wishes and thus to have recorded the desired information in a form suitable for the present-day reader. Moreover, a full comprehension

of the geographical problems could scarcely have been expected of observers during that period.

We do find, however, that you and scores of geographically-minded contemporaries each in his own way made a tolerably good start toward recording the geography of that period. The start has sufficient merit to warrant a carrying forward of that work. By drawing upon all the sources of information and fitting the parts together it may be possible to achieve an authentic representation. At the outset, however, severe limitations of place and time must be imposed. We must relinquish any attempt to cover the geography of the United States inland from the seaboard area, simply for the want of material with which a geographer may work with confidence. Nor can we, with a feeling of security, prepare a geography of the seaboard area prior to the 1790's and 1800's. The problems involved in doing this for the specified area and time are great enough at the very best. It is necessary rigidly to enforce this rule regarding the time element to be assured that all the material which is admitted will be actually contemporary with this period.

Inasmuch as it is proposed to follow the "suitable style" in part tried out by Volney and Drayton—a style which has found favor in modern times—it will be in order to overlook international as well as interstate lines and thus consider maritime Canada and East Florida as essential portions of the Atlantic seaboard area.

This program would perhaps meet with the approval of the authority on American geography at the turn of the last century. Many of the materials available possess features in which modern geographers may take some pride. Macaulay, who was a young man when you died, remarked that "a people that take no pride in the noble achievements of remote ancestors will never achieve anything worthy to be remembered with pride by remote descendants."

NOTES

Page 188: The letter chosen as a precedent appeared as a 16-page pamphlet from the press of Thomas Nicholson in Richmond, 1795. Bibliographers have attributed its authorship to St. George Tucker.

Mr. Waterman's account of Morse, appearing in the *Dictionary of American Biography*, 1934, XIII, pp. 245–247, summarizes and adds to a few earlier biographies, none of them exhaustive.

Page 190: Mitchill's letter to Morse is in the manuscript division of the New York Public Library and has been reproduced in its *Bulletin*.

A large share of the material from which Ebeling prepared his compendium is in the Harvard College Library to which it was presented by Israel Thorndike.

Page 192: M. Legaux, resident near Philadelphia, was probably the "Mr. L." referred to by Brissot de Warville in his *New Travels in America* as being "very attentive to meteorology."

Morse may have selected the letter "to a friend in England" from an article of similar but longer title in the *Columbian Magazine*, I, 1786: 117–122. Brissot has framed this in the form of a parable on pages 330–336 of his *New Travels*.

Page 193: Fred L. Pattee, *The First Century of American Literature, 1770–1870*. Boston, D. Appleton-Century, 1935, p. 125.

Page 193–4: For a fuller discussion of the geographical materials available for this period and

area and the methods employed in testing their reliability see the author's preliminary paper, "Geographical materials bearing upon the geography of the Atlantic Seaboard, 1790 to 1810," in the *Annals of the Association of American Geographers* for September, 1938.

Page 195: David Lee Clark, *Charles Brockden Brown, a Critical Biography.* New York, Columbia Univ. Press, 1934.

Volney's personal oddities were found to have much bearing upon his success as an interpreter of America and the estimate of that success in the minds of others. His characteristics are in part brought out by Samuel Breck in a manuscript dealing with early members of the American Philosophical Society, preserved in its library. An interesting sidelight on this vanity is provided by his adoption of "Volney" as a surname to replace his real name "Chasseboeuf" which he considered slightly ridiculous. He was prevented from making many valuable contacts through his reputation as a radical and an atheist. His atheistic attitude may have permitted him to view his problem more objectively than was possible by other more theological observers. Nevertheless, his real or supposed atheism often exposed him to open ridicule and perhaps served to increase the "sour temper" of which others accused him. Amusing now is the incident recorded by Samuel F. Bancroft (in the *Boston Weekly Magazine,* II, 1803–04: 18) who was a fellow-passenger of Volney on a storm-tossed vessel on Lake Erie. The French visitor, never a happy traveler even under the best of circumstances, appears to have become alarmed for his safety and rushed on deck, pockets loaded with treasured belongings, shouting, "Oh, mon Dieu, mon Dieu—qu'est ce que je ferai, qu'est ce que je ferai," whereupon Bancroft returned, "Eh bien, M. Volney, vous avez, donc, un Dieu à présent."

Page 195: The Drayton manuscript is in the Charleston Library Society.

Page 196: Jedidiah Morse, *A Report to the Secretary of War of the United States on Indian Affairs* [etc.]. New Haven, Howe and Spalding, 1822. 400 pp.

Page 196: The Hawkins manuscript is in the American Philosophical Society library and was published in *Collections of the Georgia Historical Society,* III, Part I, 1848 as "A sketch of the Creek Country in the years 1798 and 1799."

II

THE LAND AND THE SEA: THEIR LARGER TRAITS

> "After having instructed us in all political subjects, and principally those on which depend internal and external peace and the security of individuals, you will have to contemplate the soil of America as relative to human industry which, in its turn, influences prodigiously the different modes of living." *M. Claviere to Brissot de Warville.*

THOMAS Jefferson, while Secretary of State, viewed the North America of his time as comprising two great geographic provinces. The one province, facing inland and destined later to be expanded under his own guidance, he denominated the "landboard." The outward-facing slope, the Atlantic coastland, was, of course, the seaboard. The former term, which has perhaps never been used since,[1] serves less to demonstrate Jefferson's originality (which some have lately doubted) than to show that he applied a handy name to a distinctive regional entity, one widely recognized at the time. Others of his contemporaries referred, with less precision and geographic insight, to the "back country" and to its inhabitants as "backwoodsmen." On the other hand, the authentic word "seaboard" has survived in the common language, identifying to all generations the eastern fringe of North America.

This elongated if narrow coastal land, possessing no single element of natural unity save frontage upon and contact with a common sea, was without question the most significant part of North America at the opening of the nineteenth century. The recognition of this significance did not wait upon the philosophical speculations of a later, possibly more enlightened age. Contemporary observers, distinguished men like Jefferson, others more humble as was the author of the following passage, were keenly aware of the preeminent position of the Atlantic Country. "In casting our eyes over . . . North America" (wrote an author whose name can only be surmised) "our observation is powerfully struck by the peculiar situation and appearance of the tract of country reaching from the mouth of the St. Lawrence to the Gulf of Mexico."[2] Remarkable attributes of this coastal fringe were its immense frontage on the Atlantic, its innumerable harbors and navigable rivers, and its abundant food resources supplementing those of the land. The whole sea-

[1] John Pickering, "Memoir of the present state of the English language in the United States of America, etc." *Memoirs of the American Academy of Arts and Sciences,* III, 1809: 439–536.

[2] Jonathan W. Condy, *A Description of the River Susquehanna.* Philadelphia, 1796.

board comprehended within its bounds "every eligible variety of soil and climate."

In such terms, which seem to readers of recent descriptive literature curiously modern in tone, the more thoughtful citizens and observant visitors from western Europe introduced to interested readers the characteristic traits of the maritime area. The majority of those to whom fell the task of describing this province in the 1790's were concerned with creating as realistic a portrayal as their abilities and available data made possible. There was little call to entice skeptical Europeans to settle in struggling colonies and thus to paint fairyland pictures of ideal climates and lands of promise. Opportunities, nevertheless, there were. Within some part of the seaboard could be found a habitat suitable to any reasonable human demand and, to a large extent, these opportunities had been revealed through long human occupance and generations of experience in the purposeful activities of life. It has often been said that nature abhors monotony; the Atlantic country, with its varied environment, provides a remarkable illustration.

THE EXTENT OF THE ATLANTIC COUNTRY

To the observant French geographer, Constantin Volney, the coastal fringe, despite its natural diversity of climate, soil, and vegetative cover, was sufficiently unified to allow its delineation as the Atlantic Country.[3] It was most notable as being the "seat of the nation," the part of the country having the densest population, the land within which civilizations of European origin, having early displaced an aboriginal culture, had become most thoroughly rooted. A modern geographer would possibly have called this coastal fringe "the American hearthland," or rather a collection of several hearthlands, if due account were taken of the French in the St. Lawrence, the mixed peoples of the central part, and perhaps also the remnant of a long Spanish occupance in East Florida. Already each main center of occupance could count its past in terms of more than a century and a half. Quebec, Boston, Philadelphia, and Charleston were "old" cities. Signs of decadence could occasionally be observed. Along the Georgia mainland were several "dead towns," including Old Ebenezer, Sunbury, and Frederica, the latter in ruins by 1790. Curiously, the two extremities, East Florida and Newfoundland, could claim the longest past, if not the greatest landscape changes resulting from human occupance.

Neither Volney nor Jefferson defined the Atlantic Country precisely, or as precisely as one might wish, but it can scarcely be doubted that the provincial areas they recognized were similar, if not identical, in outline. There is the possibility that during the many conversations and letters exchanged between these two men the problem had been discussed. The only precise way of delimiting one region from another—a fixed line on a map—was not a common procedure at this time. It would seem in the case of Volney, who mapped in color the presumed limits of the structure regions of eastern North America, that he considered the method

[3] *Tableau du Climat et du Sol des Etats Unis d'Amerique.* Paris, 1803.

inapplicable in delimiting the less tangible geographic provinces. In fact there appears to have been no observer of the time who assumed this responsibility: all writers were uniformly content with a rather loose definition. However, embedded in their writings or suggested on their maps are ideas and data from which it seems possible to reconstruct the inland boundaries of this significant area as it

FIG. 1. The extent of the Atlantic Country, 1800.

might have been done had the necessity been more apparent. Figure 1 represents such a reconstruction.

The inland limit seems faithfully to record the consensus of opinion held by competent observers at the time. More than this, it may be regarded as a useful line of division. It must be observed that this inland boundary does not identify throughout its great extent a line of cleavage between unlike surface phenomena,

nor does it follow any single feature, natural or cultural. By no means is it a "population" or a "frontier" line. Mainly it is a line medial to a zone of cultural change, thus corresponding occasionally with basic natural conditions. This zone of cultural change is sometimes narrow and easily identifiable as in central New York, sometimes broad, as in eastern Pennsylvania. In western New England the line of separation is avowedly arbitrary, but it may be said that any other line would be still more conventional. The attempt has been made to eliminate undue complexity in order to provide a convenient line, one by whose use a cross-section of the Atlantic Country at the opening of the nineteenth century will be made possible.

THE FACE OF THE LAND

The Southern Section

From Maryland southward the boundary follows the inland limits of the coastal plain. Here, in the rivers which cross from the Appalachian piedmont to the Atlantic, a series of rapids and falls stretches for many miles along their courses. The "line" thus marked by the falls is continued in many interstream areas as a belt of dissected, sandy hills often called at this time "barrens." The significance of this belt of transition was early detected. To the west, all agreed, lay a very different country, the "upland" as it was currently called, different in respect to surface and soils and unlike also in its principal occupations. Eastwardly lay the maritime plains or, as they were more commonly designated, the "low country," widening in extent from north to south. In later times this stretch of the seaboard was called "tidewater." In the period under observation, this term seems not to have been in common usage, though the relationship between the "fall line" and the limit of tidal action on rivers from the Delaware to the James was well understood.

That this zone of transition represented the limits of the Atlantic Country was implicit in the thought of the time. Occasionally this idea was directly stated, and there are several instances of its precise recording upon a map. By 1800 the term "fall line" was no novelty. Lewis Evans in 1755 appears to have been the first to observe in writing that the falls of the southern rivers were related to a traceable line of contact between unlike physiographic provinces.[4] Volney and other writers of the period frequently refer to the "border ridge" marking the former shore of the sea across which rivers now flow in cascades, and aver that "these falls are the limits of tide waters." Dr. Samuel L. Mitchill, in a review of Volney's *Tableau*, shows that the Hudson River is an instance of tidal action extending beyond this ancient border ridge, for the tide proceeds "beyond Albany, 170 miles higher than the layer of granite."[5] Towns and cities had developed at greater or less distances

[4] *Geographical, Historical, Political and Mechanical Essays etc.* Philadelphia, 1755. George P. Merrill in *The First Hundred Years of American Geology*, New Haven, Yale Univ. Press, 1924, p. 4, incorrectly attributes the priority of recognition of the fall line to Johann David Schoepf. Schoepf travelled along the seaboard in 1783–1784, and his account: *Beitrage zur mineralogischen . . . von Nord Amerika . . .* was published in 1787.

[5] *The Medical Repository*, II, Second Hexade, 1805: 192.

downstream from the falls, including Trenton (Delaware River), Philadelphia (Schuylkill), Joppa (Gunpowder Creek), Elkridge (Patapsco), Georgetown (Potomac), Fredericksburg (Rappahannock), Hanover, Virginia (York), Richmond (James), Petersburg (Appomattox), Halifax (Roanoke), Raleigh (Neuse), Camden and Columbia (branches of the Santee), and Augusta (Savannah). In the interior of Georgia similar sites were occupied by military forts such as Fort Fideus on the Altamaha and numerous villages of the Lower Creek Nation on the Chattahouchee and Flint rivers.

Villages and towns upstream from these crucial sites were almost invariably referred to as "inland towns." None of these had increased to sizes comparable with the towns on the seacoast or at the falls. To Isaac Weld[6] it was "very evident . . . that the best situation for a trading town must be upon a long navigable river so that the town may be open to the sea, and thus enabled to carry on a foreign trade, and at the same time be enabled, by means of an extensive water communication in an opposite direction, to trade with distant parts of the country." The extent of this trade determined the size of the town or city. A town need not be very far from navigable water to be classified as an "inland town." Every traveler who recorded his observations on Lancaster, Pennsylvania, was careful to mention that with its population of about 5,000 it was the largest inland town in the United States.

By the application of the term "maritime plain" to the area now known as the coastal plain, contemporary writers were hopeful of conveying two fundamental ideas: that the area was not only maritime in position and trade connections, but that it was also maritime in origin. Volney, intellectually indebted to several earlier writers, outlined this area as the "region of sea sand," explaining that it had been elevated from a former submarine position. Within this structural region he included not merely the southern plains already outlined but also, and correctly, the larger part of Long Island and Cape Cod of Massachusetts.

These regional delineations and hypotheses as to origin were confirmed by other observers, who also added details to the larger view. Following his studies of the Virginia coast in 1799, Latrobe was assured that the "Neptunian origin of this whole extensive country" of the low maritime plain could no longer be regarded as a mere hypothesis.[7] Latrobe also held that the constructional features in evidence at Cape Henry were but a small-scale sample of the entire south coast. The spring tides were observed to carry sand above the average high-water mark, with onshore winds moving it still farther inland. Sand hills thus characteristically fringed the shore; these, constantly shifting, slowly were encroaching upon the stunted forest. Of these woods, "many thousands are already buried in sand, which overtops their summits and threatens the whole forest with ruin." In this process a lighthouse had become partly submerged.

[6] Isaac Weld, Jr., *Travels through the states of North America and the provinces of Upper and Lower Canada during the years 1795, 1796 and 1797*. London, 1799, p. 31.

[7] Benjamin H. Latrobe, "Memoirs on the sand hills of Virginia," *Transactions of the American Philosophical Society*, IV, 1799: 439–444.

In South Carolina essentially the same conditions were observed by a geographically-minded governor of that state. He writes:[8] "The shore of South Carolina rises gradually from the Atlantic Ocean . . . ." From the islands which fringe the Carolina coast "the mainland presents a level country, with a surface of light, black earth on a stratum of sand, and that sometimes resting . . . on a stratum of marl or clay." These plains "are without any stones on their surface, for eighty miles or more from the sea, rising by an almost imperceptible ascent to that distance. Michaux[9] also was impressed by the well-assorted soils, writing that "the low country of the two Carolinas extends from the borders of the sea for a hundred and twenty or a hundred and fifty miles, widening as it gets toward the south. The space that this extent embraces presents an even and regular soil, formed by a blackish sand rather deep in parts, in which there are neither stones nor flints; in consequence of which they seldom shoe their horses in that part of the United States."

The Central Section

The interior limits of the Atlantic Country in Pennsylvania and New York may be fixed with confidence only at a few points. Between these points, which are believed to be critical, a generalized line has been drawn through the intervening areas.

The most critical point in this section is the well-known Mohawk Lowland whose possibilities as a corridor of travel between the coast and the Great Lakes had already been recognized and in part realized. Contemporary authorities are in agreement that the Hudson Valley northward to Albany was properly a part of the Atlantic Country: commercially integral with the sea, this valley had long been settled and now contained a population density of from 45 to 90 to the square mile, comparable with that of coasts of Long Island Sound. Even in pre-Revolutionary times the lands along the Hudson and the Mohawk had been apportioned into large and small land grants, patents, and manors, and many of these had been subdivided into small farms.

Travelers ascending the Mohawk Valley from Albany saw no essential difference between the cultural landscapes of the Hudson and Mohawk valleys until their arrival at Rome, New York (Old Fort Stanwix). This was the head of navigation on the Mohawk River now that a short canal around Little Falls, constructed in 1795, was in operation. The scene from Albany to Rome was that of a well-settled country. Except for occasional breaks, such as that caused by the barren sand plain near Schenectady—a distance of 17 miles of unoccupied land—the settlements were continuous with from three to six homesteads per mile.[10] Especially notable

[8] John Drayton, *A view of South Carolina as respects her natural and civil concerns.* Charleston, 1802, p. 6.

[9] Andre Michaux, *Travels to the west of the Alleghany mountains.* London, 1805, p. 286.

[10] "Journal of the Rev. John Taylor's missionary tour through the Mohawk and Black River countries in 1800," *Documentary History of New York,* III, 1850: 685.

for maturity of development were the settlements at German Flats (well occupied by 1726), Johnstown and Canajoharie.

To the west of Rome lay a new, raw land, rapidly emerging from the wilderness but still sparsely peopled. From here westward to the Genesee River was a former Indian country now in the throes of land speculation and promotional schemes—a forerunner of similar schemes which preluded the settlement of so much of the Middle West. The thoughts of prospective settlers, who came mainly from New England and Pennsylvania, were preoccupied with speculations as to the opportunities for a livelihood in the "Genesee Country," the "Military Tract," and the "Ten Towns on the St. Lawrence," new names to conjure with at this time.

One may recapture something of the nature of this new land beyond the older Atlantic Country by reference to a few contemporary observations. An observant traveler to Niagara Falls refers to "land-grabbing" in the Military Tract in the Finger Lake district, an area consisting of 1,500,000 acres of land surveyed into 25 townships of 640-acre rectangular sections. Here "each soldier had a patent made out for six hundred [and forty] acres. These patents were soon bought up by speculators, who very rarely gave more than eight dollars . . . for each patent . . . now selling from three to six dollars per acre."[11] Typical of this feverish settlement of the military lands was the planting of wheat and other grains among the stumps of recently cleared fields inadequately prepared for cultivation by shallow plowing or harrowing. European visitors were, of course, duly impressed with these conspicuous evidences of recent settlement and did not fail to record such scenes in their travel notes. One such traveler was Chateaubriand who wrote of western New York in the 1790's that its landscape "exhibited a curious mixture of the state of nature and the civilized condition. In the corner of a forest which had never rung but with the shouts of the savage and the braying of the fallow deer, you met with cultivated lands; you perceived from the same point of view the hut of an Indian and the habitation of a planter. Some of the habitations already completed, reminded you by their neatness of English or Dutch farmhouses, while others were but half finished and had no other roof than the dome of a spreading tree."[12]

The youthful Washington Irving, accustomed to the more mature landscape of an older area, painted a very dreary picture indeed of the "western country" of his state as seen on a journey in 1803. In the Black River region, according to his notes not polished for publication, "the roads were very bad and the country around afforded but little variety of prospect. We were a great part of the time passing through thick woods and underwood being so thick as to prevent our seeing to any extent. When we were out of the woods we had nothing to entertain the sight

[11] John Maud, *A Visit to the Falls of Niagara in 1800.* London, 1826, p. 38.
[12] Viscount de Chateaubriand, *Travels in America and Italy.* London, 1828. I, pp. 123–124.

but fields undiversified by any great variety of Trees or hill or brook, disfigured with burnt roots and stumps and fallen bodies of trees."[13]

The "newness" of western New York is epitomized by the scene at the present site of the great city of Buffalo, which consisted in 1798 of five dwellings, one tavern and one store, all constructed of logs. The mail to Buffalo, first received in 1803 by horseback, continued to be thus carried once every two weeks until 1806 when a weekly route was established.[14]

These few passages selected from a large number of similar import indicate that the Mohawk-Wood Creek divide was not only a water parting but, during the period under consideration, was also a cultural landscape divide of the first magnitude.

Southward of this critical area, in southern New York and Pennsylvania, the east branch of the Susquehanna River may be taken as roughly marking an inland limit of the Atlantic Country. This boundary has been chosen from among many possibilities for its convenience and simplicity. The area seawards of it includes the northern part of the coastal plain in New Jersey, the piedmont region west of Philadelphia and the eastern fringe of the Appalachian highland area. As explained more fully in a later chapter, this part of Pennsylvania was closely tied by road or river navigation, and as well by tradition, to the city of Philadelphia, the second largest in the country with a population of nearly 50,000. This enumeration does not, however, adequately measure its significance to and its influence upon the hinterland. The adjacent country, even that lying beyond the Susquehanna, had a population of from 18 to 45 persons to the square mile, a density typical of the seaboard from the Piscataqua River in Maine to Pamlico Sound in North Carolina.

The Northern Section

The remaining large segment of the Atlantic fringe—New England and Maritime Canada—may be differentiated from the distinctly "landboard" regions with considerable confidence. The majority of contemporary writings directly or impliedly state that this represented an important part of the Atlantic Country and that it possessed within itself strong elements of unity arising from historical background and natural environment. There is no suggestion that it is reasonable to subdivide this large section into a distinctly seaboard and an inland region; such a line drawn on a map would be of the most arbitrary character. Large portions within the outer boundaries lay remote from maritime connections. Included also were "islands" of sparse population, culturally unlike the coastal margins. With such insular areas this study will naturally have little concern.

The Hudson River valley and the Lake Champlain lowland to the northward was at this time considered a major physiographic boundary, much more so, in fact, than in modern geographic thought. There was no disposition to consider

[13] Washington Irving, *Journal, 1803.* Edited by Stanley T. Williams, London and New York, Oxford University Press, 1934, p. 13.

[14] *Documentary History of New York, op. cit.*, III, p. 726.

the New England section as allied to the Appalachian highlands: little resemblance could be detected between the major lineaments of New England on the one hand, and those of eastern Pennsylvania and states to the south, on the other. It must be pointed out that this was a time antecedent to careful geological studies which, many years later, revealed the existence of obscure structural ties between the two sections. Dependent for analyses of earth features mainly upon their form or appearance rather than their origin, observers in the 1790's saw no connection between the northeastern highlands and the southern Appalachians.

The distinctive physical quality of the New England area, aside from its prevailingly hilly or rugged character, is the north-south trend of its principal features. This is in contrast to the Appalachian highlands wherein the trend of the ridges is from the northeast to the southwest, in this respect paralleling the seacoast south of the Hudson. Volney identified the northeastern highland or upland area with his "granite region," an expression used in contradistinction to his "region of sea sand" which was coextensive with the coastal plain. This thought seems to be distinctly helpful in presenting a broad view of the Atlantic coast, even though when considered in detail his "granite region" is by no means all granite. He apparently used this specific term for want of the more general expressions "crystalline" or "complex rocks," in common descriptive usage today.

Descriptions of the northern segment of the Atlantic fringe necessarily lack the simplicity of those relating to the southern maritime plains. The best thought of the time followed closely Thomas Pownall's earlier analysis of New England, and his views, in turn, revert to those of Lewis Evans.[15] According to this analysis, the coastal lowlands of Massachusetts and Connecticut, and their projections into the larger river valleys, especially the Connecticut Valley, were distinguished from the more rugged interior. It is altogether remarkable how closely this grouping of the lowland features coincides with the area designated "seaboard lowlands" by Nevin M. Fenneman on his map of the physiographic regions of the United States. The lowlands of fresh water rivers (upstream from tidal influence) are designated as interval or intervale lands, a useful descriptive term which might well be revived. East of the Connecticut intervale, which was observed to be the largest lowland area in southern New England, lay the "piedmont," a higher, hillier, and rougher country, the same area which in modern times is called the eastern upland. The highest portions of this piedmont were represented by isolated hills increasing in elevation from south to north, that is, the "middle range" in eastern Massachusetts and Connecticut and adjacent New Hampshire. This line of hills culminated, according to Pownall, in the "high Peaks of Monadneag (Monadnock)." Beyond these northward lay the highest elevations in New England, the White Hills. A corresponding north-south-trending, rugged to mountainous country between the troughs of the Connecticut and Hudson rivers was the Taconic range. These

[15] In 1776 Pownall, a provincial governor of Massachusetts, reissued *Evans' Geographical* Essays with some additions of his own.

higher elevations of course attracted much interest and thought: people speculated as to their heights, extent, and possible effect on the seaboard climate. The White Hills or mountains, wrote Jeremy Belknap,[16] "are the highest part of a ridge which extends north-east and south-west. . . . The area of their base is an irregular figure somewhat resembling an isosceles triangle whose longest extremity is toward the south and whose whole circuit cannot be less than fifty miles." Belknap overestimated the heights of the mountains, but by 1804 the maximum elevations were fixed at less than 7000 feet through barometrical observations by the meticulous Nathaniel Bowditch.[17] The Taconic Mountains, it was noticed, offered a marked contrast with the topography of the Catskills across the Hudson, which seemed to confirm the belief in the lack of connection between the two eastern highland areas. Dr. Mitchill pointed out that in the Catskills "the horizontal disposition of the strata is continuous from the base quite to the tops of the highest ridges, and a remarkable sameness prevails throughout the whole," with the steepest ascent on the eastern side. On this basis the Catskills were correctly allied to the western Appalachian plateau area. While making these observations on the east slopes of the Catskills, Mitchill wished to obtain a view of the Taconics, in order to compare the two mountain areas, but his view was interrupted by woods. Having laboriously cut down a swath of trees to permit such an observation, he was gratified to see "the country spread like a map before me," and to witness from that vantage point the greater complexity of the Taconic range.[18] Following a later study of the highlands of New Jersey, Mitchill was still unconvinced that the northeastern and southern highlands were topographically connected. Schooley's Mountain especially seemed to have no essential connection with either the Catskills on the one hand or " the great Alleghany, that traverses the continent to the confines of Georgia," on the other.[19]

Northward of the Penobscot River, descriptions of the surface of the maritime country became increasingly confined to the immediate vicinity of the coast line; the interiors of the peninsulas, islands, and mainland remained relatively unknown, as many have to the present day. Many were the speculations about the interior lands of New Brunswick, Gaspe, and Newfoundland. Volney believed that the Notre Dame and Magdeleine ranges were actually northern extensions of the Taconics. Newfoundland was seen by most travelers as "an immense island, abounding with numerous harbours, some of which are very capacious and extend a great distance into the country; but the interior never having been perfectly explored, the greatest part of the island remains an unknown wilderness."[20] All of

[16] *Transactions of the American Philosophical Society*, II, 1786: 43.

[17] "Heights of the White Hills, N. H.," *Memoirs of the American Academy of Arts and Sciences*, III, 1809: 326–328.

[18] "A short account of the Blue Mountains," *Philadelphia Magazine*, III, 1798: 127–133.

[19] Samuel L. Mitchill, *Concise description of Schooley's Mtn. in New Jersey.* New York, 1810, p. 6.

[20] John Lambert, *Travels through Canada and the United States of North America, 1806–1807, 1808.* London, 1816, I, p. 3.

this north country was not, however, of a mountainous character. It was said of Nova Scotia that "throughout the peninsula is in no part mountainous but frequently rises into hills of gradual ascent." The long-inhabited Prince Edward Island was described as being in general level, having but few hills and none of them very high or steep, probably the highest spot on the Island does not rise five hundred feet above the level of the sea."[21]

"And in a more general sense, one may call New-found-land all the neighborhood of the Gulf of Canada." Thus wrote Marc Lescarbot in 1615, a characterization which would apply equally well to the same area during the period under consideration. The steep shores of the St. Lawrence, converging to the city of Quebec, allied this lower country with the rugged coast. But upstream from there to Montreal, a distance of 200 miles, the land "is flat, or so easy a rise as to be scarcely perceptible, and the hills at a greater distance than the eye will carry."[22] This was the heart of French Canada, first settled contemporaneously with Massachusetts Bay, a land of moderately dense population and mature cultural landscape. Though far from the open sea, the St. Lawrence lowlands were connected with the Atlantic by the greatest river of eastern North America and were an integral part of the Atlantic Country. A few miles upstream from Montreal at La Chine a different country was encountered: one, like its close neighbor in western New York, undergoing a type of settlement which broke sharply with the old-established order in the lowlands below the rapids. Here, then, is a suitable inland limit for the Atlantic Country of maritime Canada.

THE FORESTS AND THE FOREST OPENINGS

Many contemporary observers, with rare breadth of view, had called attention to the larger features of the seaboard's forest cover and as well to its local composition and degree of alteration by man. Broadly speaking, the Atlantic Country was, as it still is, a wooded land, a feature of the face of the land so conspicuous, especially to visitors from more densely peopled European countries, that descriptions always abound with reference to this aspect of America.

Three principal forest formations, each roughly corresponding with one of the three larger sections already outlined, broadly overspread the Atlantic fringe. Only one of the three forests, however, belonged exclusively or mainly to the maritime country. That one was the Southern or South Atlantic forest, recently so named by the French geographer Baulig. As another French geographer, Volney, pointed out in 1803, the sandy coastal plain "forms the basis of a forest of pines and firs and other resinous trees." Stunted or altogether wanting in numerous coastal situations as in eastern New Jersey (long named on maps "The Desert"), or occasionally mixed with deciduous trees in cut-over areas especially toward its northern limits,

[21] John Stewart, *An account of Prince Edward Island, in the Gulph of the St. Lawrence, North America.* London, 1806. p. 23.

[22] D. Campbell, *Travels in the interior inhabited parts of North America in the years 1791 and 1792.* Edinburgh, 1793. p. 133.

this pine forest extended in a widening area southward into Georgia. The longleaf southern pine predominated, with cypress in swampy coasts and the more tropical forms such as saw-palmetto in the Florida peninsula. The southern pine belt was popularly known as the "pine barrens," a disparaging expression which was the despair of land settlement companies in Georgia which sought, by issuing promotional literature, to dispel deeply instilled fears of soil infertility.

The other two forests of the coastal lands were extensions of continental forests to the seacoast, symbolic, to those who viewed them, of the essentially continental climate of the northern portions of the seaboard. The more extensive of these two was the Northern Coniferous or Laurentian forest, typical of northern New England and Maritime Canada. Within this realm the proportion of coniferous trees increased toward the north with a composition largely of white pine, spruces, tamarack, and hemlock. Southward of the Penobscot, broad-leaved trees were more abundantly intermixed with the conifers. The Appalachian Mixed forest, the third formation, appeared on the coast as a narrow wedge separating the northern and southern coniferous stands.

Reference to the Atlantic Country at the beginning of the nineteenth century as a forested land is intended simply as a rough generalization, the same degree of generalization, in fact, as was clearly intended by contemporary observers. Volney, for example, was careful to preface his statement that "the most striking feature of America is the rugged and dreary prospect of an almost universal forest" with the remark that it appeared thus "to a traveler from Europe, and especially to one accustomed, as I had been, to the naked plains of Egypt, Asia and the coasts of the Mediterranean. . . ." He hastened to point out that this "universal forest" contained many openings, natural and artificial, large and minute. He did not add, as he should have done, that even in the forested areas, the woodland was often greatly impoverished and altered from its original state.

The majority of foreign travelers at this time were definitely unreliable in those parts of their records relating to the extent of the forests. Fresh from western European scenes, possibly from urban centers, in which forest growths assume a secondary position, they were likely to see eastern America as "three wildernesses," as Dr. Mitchill humorously pointed out in one of his many reviews. Moreover, their range of vision from road or river was altogether too limited to permit a judicious estimate. To modify a familiar expression, they could not see the fields for the woods. A remarkable instance of this is illustrated by numerous descriptions of the low country of South Carolina from which many a traveler, like John Davis,[23]

[23] A young Englishman, employed for a time as special tutor to the Drayton children on Ocean Plantation south of Charleston. Author of a book of his travels (1798–1803) which appeared also in French as "Sejour dans les Bois de la Caroline du Sud," he was given to writing poetry. His odes picturing the forests appeared in magazines. The first two lines of one:

"Deep in the bosom of a lofty wood,
Near Coosahatchie's slow-reaching flood . . ."

brought back dismal pictures of deep forests and little else. Unless the traveler strayed from the main roads in this low country, he was unlikely to see the larger clearings customarily at one- or two-mile distances from the forest-bordered road. One traveler, having reached a point about 25 miles west of Charleston, wrote:

"I had now fairly entered the *pine barrens*. . . . A habitation was seldom seen, except at intervals of ten or twelve miles, or when you approach a savannah or swamp; for the plantations are all settled a considerable distance from the roads, and paths of communication are cut through the woods; so that in travelling through the southern states, you are enveloped in almost one continuous forest. A contrary practice is adopted in the northern and middle states, where a succession of farms, meadows, gardens and habitations continuously meet the eye of the traveller; and if hedges were substituted for rail fences, those states would very much resemble some of the English counties."[24]

The Atlantic seaboard during this decade was a land of retreating forest and advancing fields, an acceleration of the same process which had continued uninterruptedly for uncounted centuries. There was a rough approximation between the density of population and the amount of cleared land, reaching a maximum from southern Maine to southern Virginia, the same area within which the antecedent Indian population had been most densely settled. Dr. Franklin earlier pointed out that "agriculture is the main business of our people," necessitating large cleared areas for the five million or so inhabitants of the Atlantic country.

The cleared land extended beyond the farmed area and even beyond the area in farms: beyond the cleared lands, in turn, the forests were greatly modified and often impoverished. The custom of firing the forest, which had also been practiced widely by the aborigines, was now widespread, resulting in burnt-over tracts or absence of undergrowth. The latter was especially conspicuous in the pine barrens. The trustworthy John Drayton assures us that the pine barrens of South Carolina "have little or no underwood, some species of oak excepted; the ground being covered with coarse wild grasses. This is probably not its natural appearance, but is caused by the custom of burning the dry grass in the spring in order to hasten early pasturage, at the same time destroying the young shrubs which would, otherwise, shoot up a growth of underwood." Drayton also suggests that the forest had been locally injured and partially destroyed by insects. This was the burden of a letter written to Dr. Barton in 1803.[25] It appears from this communication that pines along the Santee Canal near Charleston had become infested with a winged insect which, in the caterpillar stage, worked havoc among the trees. Several hundred acres of the finest forest in that locality had been destroyed by this voracious insect.

The extension of the cut-over area beyond the amount needed for farm use resulted mainly from the cutting of wood for fuel and industrial purposes. The forests of coastal New England were greatly reduced by the combined onslaught of the settler clearing land for farming and the demands for fuel and timber. In a com-

[24] John Lambert, *Travels through Canada and the United States of North America, 1806, 1807, 1808.* London, 1816. II, p. 232.

[25] John Drayton to Benjamin S. Barton, October 7, 1803, MS American Philosophical Society.

munication published in 1814, General Lincoln[26] writes: "If we take a survey of the northern and eastern states, we shall find that our timber trees are greatly reduced and quite gone in many parts. In towns near and bordering on the seashore little now can be found within the distance of twenty miles, and it is not uncommon for the builder to send at this day from thirty to forty miles for timber and planks, and the stock is fast diminishing not only from the demand for timber and planks, but from the necessity of fuel." New England winters especially proved a heavy drain upon the surrounding woods. It may be inferred that much of the fuel supply for the thickly settled Boston area was derived from southern New Hampshire. At least, during the campaign for raising funds for the canal in the Merrimac River around Amoskeag Falls, the plea was made that the canal would be used not only for "the conveyance of country produce and lumber of every kind, but particularly for the very important article of fire-wood."[27] Viewing the rapidly diminishing wood supply, Dr. Benjamin Barton considered it a most fortunate occurrence for New England that coal supplies had recently been discovered in Rhode Island.[28]

The manufacture of pot- and pearl-ash, a major industry during this period, further extended the area of cut-over land. According to one account this industry, in many cases a separate undertaking and not simply an adjunct to farming, "is well known to be the greatest branch of manufacture in the five northern states."[29] The manufacture of ash was so important that, according to Dr. Mitchill, two inspectors were appointed yearly to pass upon the quality of the export product at the port of New York, and one also at Albany.

Frequently there appeared in current magazines anonymous comments on the scarcity of lumber, the high cost of fuel wood, and the necessity for instituting measures of conservation. Some of these comments are as fresh as though they had been printed this year. One example may suffice. A correspondent to a magazine in 1798[30] called attention to the need of preventing further devastation as well as to repair injuries already committed, and proposed (1) the establishment of state, county, and township forests, (2) strict regulations to be imposed upon the use of pirvately owned woodlots, (3) the maintenance of roadside forests, and (4) thinning, cutting of mature trees, prevention of fire, and the sale of wood for the "relief of the poor of the neighborhood."

Natural Openings

There were also numerous "openings" believed to be of natural origin and still others apparently "natural" but more likely Indian old fields. Natural meadows

[26] "On the cultivation of the oak," *Collections of the Massachusetts Historical Society*, I, Second Series, 1814: 189.

[27] *Columbian Centinel and Massachusetts Federalist*, Jan. 29, 1800.

[28] "An inquiry into the chemical character and properties of that species of coal lately discovered at Rhode Island," *Philadelphia Medical and Physical Journal*, 3rd Supplement, 1809: 221–235.

[29] *American Museum*, VI, 1789: 207.

[30] "On the importance of preserving forests in the United States," *Weekly Magazine of Original Essays* (Philadelphia), II, 1798: 78–81.

in the intervales of New England rivers and the Hempstead Plains of Long Island are excellent examples.

In one part of the Atlantic Country where aboriginal culture, though still largely unmodified by white contacts, was nevertheless under observation by official Indian agents, it was possible to observe directly the way in which Indian old fields came into being. This was through the practice of "shifting cultivation," firmly institutionalized among the members of the Lower Creek Nation in interior Georgia. It was customary for village sites to be transferred to new locations in order to replace worn-out lands for new, to replenish wood and game supplies, and to escape from diseases known to be associated with poor sanitation resulting from years of residence in the old site. Commonly, the name of the village was transported with the village itself, introducing some interesting geographic problems. Without doubt many of the open areas in this southern district were of this origin. It was the opinion of the traveling botanist William Bartram that most of the savannas of north Florida were actually abandoned Indian fields. He cited the extensive Alachua prairie in the present central lake region as a classic example.

THE SEACOAST AND THE SEA

The eastern fringe of the continent acquired much of its character through an extraordinary intermingling of land and sea throughout its entire length. Broad bays extending deeply into the land, peninsulas and headlands reaching out into the sea, innumerable islands scattered promiscuously along shallow shores, great estuaries carrying tidal action in brackish waters remote from the open sea, brought the varied land and the uniform sea into intimate relation. Contemporary writers, little concerned with the possible genesis of this coastline, viewed the intermixing of land and sea in a thoroughly practical way. Their descriptions are, in fact, as dry as dust, so great was the concern to "lay down the coast" by word and chart with all possible accuracy. It was a matter of practical concern because the safety of shipping was at stake.

Contemporary charts of the coastline are therefore more revealing than the occasional circumstantial accounts which sometimes accompanied them. From these charts, on large and small scales, it may safely be inferred that the available knowledge of the Atlantic coastline in 1800 approached closely to absolute truth. Thus, if a coastal chart were compiled from the better sources of the time, drawn to a moderate scale—one suitable for this page—and placed side by side with one drawn from modern sources to the same scale and containing no other earmarks as to date or origin, a practiced eye would be needed to identify the earlier example. With increasing size of chart scales the discrepancies between the 1800 charts and those of today become more obvious. All such discrepancies, however, may not be due to shortcomings in the earlier chart, because of the many detailed changes in the coastline during the century and a half since their construction. A recent author,[31] writing of the North Carolina coast from authentic sources, has cited an

[31] Charles C. Crittenden, *The commerce of North Carolina, 1763–1789*. New Haven, Yale University Press, 1936.

excellent example of this. The North Carolina coastland, with its cuspidate barrier beaches familiar to all map readers, was early regarded as a danger point in shipping, as evidenced in two of the names bestowed upon its three famous capes—Hatteras, Lookout, and Fear. "Except the Cape Fear, not a single river empties directly into the ocean within the boundaries of the state; and on the Cape Fear [navigation] is rendered hazardous by the shoals which obstruct its mouth." Entrances into the sounds were therefore of special significance. The barrier beaches behind which lie Pamlico and Albemarle sounds are subject to changes in outline, especially in the passages through and between them. During the eighteenth century, it appears, more than two dozen inlets were in existence but only three were of commercial significance—the mouth of the Cape Fear River, Old Topsail, and Ocracoke. These inlets had minimum depths of from ten to fourteen feet, carefully measured during this period. Contemporary charts of Pamlico (or Pamtico) Sound are liberally dotted with depth soundings which were presumably accurate at the time they were made but do not always correspond with soundings on recent charts.

The reasonably precise knowledge of the coastline then attained was in great part a heritage from a long antecedent period of coastline charting. During the decade under consideration this accumulated store of knowledge was expanded and further refined; additions appeared in the form of pilot charts, in manuals of sailing directions for the coastwise trade, and in log-books of privately owned vessels. The log-books are especially interesting. Many of these, deposited in institutions such as the Peabody Museum and the Essex Institute in Salem, Massachusetts, contain perspective sketches of coastlines as they appear from certain compass directions and distances. They also contain ground-plan sketches of harbors and channels, the location of shoals, and soundings within the usual routes followed. Authors of these sketches, some of which are drawn with real skill by men who made no pretence to scientific knowledge, may have taken their cue from the English Pilot Charts on which coastal scenes were depicted as a means of aiding navigators in identifying their positions. This voluminous factual information contained in shipping records was usually separate from the published charts and not infrequently was guarded as trade secrets. Thus the published charts do not show the full extent of coastal knowledge at this time. Following the example set by authors in the 1790's we shall let the burden of describing the coastline rest mainly upon the map.

By 1800 it had become apparent that the Atlantic sea was not absolutely uniform from place to place; regional variations were introduced through differences in surface water temperatures and in the direction of ocean currents. The association of water temperatures with certain ocean currents was at this time being closely observed. Here again the investigators were being severely practical: water temperatures were influential in the fisheries, the direction and velocity of currents aided or hindered navigation; therefore they must be undertsood.

So much information had been gathered regarding ocean currents in the western Atlantic that Volney could discuss them with great confidence. He was most interested, as others had been, in the "Gulph Stream" which he characterized as a

"shoreless river in the ocean"—from which Lieutenant M. F. Maury, a half-century later, might have derived his somewhat similar concept. Volney's discussion of this stream, then more widely and still preferably known as the Florida Stream, was derived mainly from readily accessible sources of information, not from his own observations. Unknown to him were numerous manuscript records, some of them still unpublished, which he might have used to advantage. Despite this partial use of scientific material, his description of the stream strangely resembles modern nontechnical discussions of it. Calling attention to the accumulation of warm water in the Gulf of Mexico impelled there by the trade winds, he states that the surplus makes its exit through the Florida straits and Bahama Channel into the ocean "where its identity is still preserved, by a course of four or five miles an hour and likewise by its color and temperature, which is from 10 to 22 degrees hotter than the contiguous water. This remarkable stream coasts the whole of the United States, varying in its breadth which, at a medium, is forty-five to fifty miles. Its force is not destroyed nor its peculiar properties lost, till it reaches Newfoundland, where it diffuses itself suddenly in the direction of the northeast."

In connection with Volney's six special points about the stream it is interesting to observe that he errs only in those particulars relating to explanations. These points are: (1) It preserves a settled and distinct course from Florida to Newfoundland; (2) it conforms in direction to the American coast; (3) as it advances its force lessens and its breadth increase; (4) changes in depth and temperature are reflected in colorations of the water; (5) it has carved a deep channel in the Florida portion; and (6) the material thus eroded is carried northward and deposited: "I am indeed tempted to affirm that the Banks of Newfoundland merely constitute a bar at the mouth of this vast shoreless river." If one's faith in Volney's scientific ability is lessened by this explanation of the Grand Banks, it may be heartening to recall the hypothesis of Lieutenant Maury, one of the most revered of early scientists. As late as 1856 Maury entertained the idea that the Banks were the accumulated deposits of "earth, stones and gravels brought down upon them" by the melting of ice floes transported southward by cold currents."[32]

Volney's chart of the Gulf Stream is derived from a fusion of several already extant. The manuscript map of William Gerrard (John Gerar William) De Brahm[33] on which that portion of the stream in Florida waters is shown was, of course, not available to him. This chart is significant because it was probably the first on which the American portion of the stream was plotted on the basis of direct, scientific observations. DeBrahm's later chart, though published in 1772, was probably rare even by 1800, especially in this country.[34] The appearance of this chart nearly coincided with one which Dr. Benjamin Franklin had perfected from a rough sketch given him, at his request, by a Captain Folger of Nantucket. This

[32] *The Physical Geography of the Sea*, revised edition. New York, 1856, p. 27.

[33] Accompanying: "History of the three provinces of South Carolina, Georgia and East Florida, 1773 (?)." MS Treasure Room, Harvard College Library.

[34] *The Atlantic Pilot*, printed for the author by T. Spilsbury, London, 1772.

Folger drawing probably represented the consensus of opinion among practical navigators and whalemen who, as Franklin said, "were extremely well acquainted with the Gulf Stream, its course, strength and extent, by their constant practice of whaling on the edges of it."[35]

Franklin's greatest contribution to the geography of this period was his original observations of the temperatures of the Gulf Stream, first made by him and his nephew Jonathan Williams in 1775. These antedated by one year similar observations by Dr. Charles Blagden, to whom Volney incorrectly attributes precedence in this regard.[36] The preliminary work of these men reached its fullest effect in the decade 1790–1800 during which many navigators, including Commodore Truxton, William Billings, and William Strickland, collected information in the interests of what they called "thermometrical navigation."

Two major conclusions regarding the Atlantic sea of America seem to be in keeping with this discussion of larger traits. One is that the Atlantic seaboard part of the Gulf stream was by this time reasonably well known and charted. This was quite in contrast with the relative accuracy of the currents in European and mid-Atlantic waters, wherein the presumed direction of currents was much at variance with absolute truth. The other conclusion is that no authority at this time attributed any major effect of the Gulf Stream upon the climate of the Atlantic fringe. It was not until later that writers on the geography of the Atlantic states, groping for easy explanations of climatic phenomena, selected the stream as a way out of their difficulties. We shall now see to what extent the climatic environment was understood at this time.

[35] "Letter from Benjamin Franklin to Julien David Leroi," *Transactions of the American Philosophical Society*, II, 1786: 315.

[36] See Charles Blagden, "On the heat of the water in the Gulf Stream," *Transactions of the Royal Society of London*, LXXI, 1781, Part II: 334–344. Blagden states that his first observations were made in 1776.

III

THE SEABOARD CLIMATE IN THE VIEW OF 1800

"In an extensive country it will of course be expected that the climate is not the same in all its parts." *Thomas Jefferson*

"I dare to say, my Lord, that to all climates all kinds of states are not alike adapted."

Cinna, Act. II, Scene 2.

"WHATEVER relates to the meteorology of our country," said Dr. Barton in his discourse on natural history, "is eminently entitled to our attention." This thought, perhaps rarely stated in so many words, motivated numerous individuals in Barton's time and others long before him to apply themselves diligently to the study of the climate and weather of the Atlantic seaboard. Looking back upon this time from one in which weather problems are largely left to governmental bureaus, the extent and breadth of these investigations are altogether remarkable. As a matter of fact, had all the pertinent information been correlated, a useful and satisfactory climatic picture would have resulted. A summation, however, was not destined to occur. In widely distributed points—Salem, Charleston, Philadelphia, St. Augustine, and Windsor, Nova Scotia—careful observations of the passing weather had been patiently made and recorded. Such were the limitations in the distribution of scientific information, however, that this was not known even by those especially interested in the subject.

The specialists in climatic study were urged on primarily by a passion for knowledge for its own sake. There was not the slightest expectation of financial reward. If the weather observers believed that their records would prove of practical value to others, this is not apparent from anything they themselves wrote. Doubtless their researches seemed pointless to the majority of their neighbors who, in a manner not unlike that of any people in any age, took their climate as a matter of course. To them the weather provided a favorite topic of conversation, especially when "unusual" phenomena occurred. The seasons regularly appeared and faded, one year seemed very much like the preceding one; but they did not cling too tenaciously to this belief in the permanency of nature. The oldest inhabitant who opined that the climate is different now, found easy converts among his listeners. European immigrants and visitors spoke with conviction about the peculiarities of the American seaboard climate, comparing it, favorably or otherwise, with that of their home land. The records of the local weather man, when they were published in the magazines or the weekly newspaper, even though unaccompanied by predictions of ensuing weather, were eagerly read. It may be suspected that the records were consulted with con-

siderable intelligence. The people lived quite intimately with the weather elements, tied closely as they were to the soil and its products.

In this discussion of the seaboard cilmate we shall be most concerned with what the scientists had discovered or believed to be true. Discoveries and beliefs are always allied in the climatic view of any time, and it is difficult to say which is the more important. The discoveries add truth to the accumulated store of information; the beliefs, whether well-founded or fallacious, inspire further research and possibly condition the progress of settlement and the practical uses of the land. If the climate is believed to be changing, there is good reason for further study of the problem. If the climate of a distant locality is thought to be more genial than that of another, the effect is the same as though the distant climate is actually more favorable—the region becomes a good place for settlement. Beliefs such as these were held by the authorities. The general public embraced them in exaggerated form. As Montaigne has said, "Nothing is so firmly believed as what we least know."

DISCOVERIES AND BELIEFS IN OUTLINE

That all things may be done "decently and in order," the commonplace climatic knowledge at the close of the eighteenth century will be measured. By commonplace knowledge is meant those larger truths respecting the wind belts and latitude-and-temperature relations which, having been found reasonable and useful by men of discriminating minds, were then in acceptance. Such an individual was Nathaniel Bowditch who painstakingly entered in his "commonplace book" and several of his nautical log-books many of these larger truths. We may also learn the commonplaces from the writings of such intellects as Noah Webster and Benjamin Franklin, and from the college lecture notes (commonplaces indeed!) of Samuel Williams and Benjamin Barton. This knowledge was the scaffolding, largely erected by their predecessors, to which the meteorologists in the 1790's added their own material.

It will then be in order to summarize the discoveries which had been made—the statistical compilations of rainfall and temperature, and some interesting "experiments" in weather phenomena; and to note the beginnings, however crude, of modern weather science.

A discussion of the climatic beliefs necessarily follows the discoveries—the belief that across the Appalachians was a warmer climate, the surmises about a changing climate, and how this belief was rationalized. Equally significant are the speculations regarding climate and health.

Finally we shall outline the contemporary opinion regarding the different types of seaboard climate.

COMMONPLACES IN 1800

That the average temperature of the Atlantic coast progressively declined from Florida to maritime Canada and that this declination was comparatively more rapid than along the European coast were truths widely recognized. The better-informed

individuals knew in addition that only one other coast—that of Asia—resembled our Atlantic coast in the rate at which the temperature declined, both coasts being exceptionally high in this regard.

Professor Barton in his classroom lectures explained that the temperature of any place was mainly a function of its latitude, but that places in the same latitude often showed dissimilarities owing to such relative matters as contiguity to water bodies, the presence of mountains which might shield the region from cold winter winds, and the direction of prevailing winds. It was explained that minor factors determining earth temperatures were the relative predominance of cloudiness and the extent of man's culture in adjacent regions. In thus according some place, however slight, to the effect of cultural changes upon climate—especially the clearing of land—Barton was expressing a widely held idea with which he himself, as we know from his writings, did not wholly agree.[1]

Volney summarized contemporary thought in writing that "the climate of the maritime region [of North America] is colder in winter and warmer in summer than that of the countries of Europe under the same parallels." He had not made a careful study of this matter and was writing largely from general information. The first careful comparative study of western European and eastern North American temperatures seems to have been made by Dr. Edward A. Holyoke of Salem, Massachusetts.[2] Explaining that "almost since the first discovery of North America it has been observed that the extremes of heat and cold are much greater on this side of the Atlantic Ocean than they are in Europe," he announces that it is now possible, for the first time, accurately to measure the differences. Temperature data for many European cities had been made available[3] and these could readily be compared with similar American coast data. His conclusion from such a study was that "the air in America is hotter in summer by upwards of 8 degrees and colder in winter by 28 degrees than those parts of Europe which lie in the same latitude." The observed contrasts were to be attributed primarily to a fortuitous circumstance: the relationship of the two continents to prevailing winds. America lies to the westward of the Atlantic; hence, reasoned Dr. Holyoke, we "feel less of the warming effects of the sea in winter, as well as less of its cooling ones in summer." Western Europe, on the other hand, is under the influence of onshore winds from an ocean warmer in winter and cooler in summer than the adjacent land. The presumed greater dryness of the American atmosphere was also a factor to be considered in this problem. In this additional thought, Holyoke was paying his respects to a rather popular explanation for the same phenomena. The belief that the American atmosphere was noticeably drier or, as some would have it, more "elastic"

[1] MS lecture notes, Boston Public Library.

[2] "An estimate of the excess of the heat and cold of the American atmosphere beyond the European, etc." *Memoirs of the American Academy of Arts and Sciences*, II, 1793–1803, Part 2: 65–92.

[3] "Ephemerides de la Societe meteorologique Palatin," *Observations sur la Physique*, XLIII, 1793: 294 ff.

or "dephlogisticated" than that of Europe, was of long standing and found support with many leading intellects. In his manucript notes at the Essex Institute, Holyoke makes it clear that he regarded the relationship of the two continents to the ocean as the all-important cause: it agreed not only with scientific thought but with common sense.

These explanations marked an enormous advance over the thought of the preceding period when the markedly cold winters of northern North America were "explained" in the most fantastic ways. Perhaps some still believed in these earlier hypotheses, first advanced in Quebec by Jesuit missionaries dismayed at the apparent misfortune of France in acquiring such an unpromising part of the new continent for colonization. They opined that the long, cold winters were due to conditions, more or less vague, in the far interior—extensive forests, great water bodies, and mountain ranges. In the course of time, reasoned the optimistic missionaries (at least in writing home to the authorities), the American climate would become more congenial through gradual change.

Winds were regarded, as indicated above, as primarily influential in determining the temperature contrasts between places whose latitudes were comparable. The prevailing winds over the Atlantic were viewed in their essential simplicity, well illustrated in the entries made by Bowditch in his commonplace book. "The winds to the northward of 20° or 30° to the north of the equator are governed by no particular laws, blowing in any season from any part of the compass but in general is remarked that westerly winds are more prevalent than easterly ones & that those winds decline to the northward as the sun approaches the tropic of Capricorn and to the southward as it approaches that of Cancer." Bowditch was here referring to the westerly-wind "belt" whose equatorward limits shift seasonally. Southward of the above-stated latitudes "the northeast winds prevail, their northern boundaries marked by the calms of the sub-tropics," also shifting seasonally north and south.[4] Bowditch and his contemporaries might have derived these commonplaces from any number of available sources. The most likely guess is that the above passage came from Dalton who, in turn, ascribes priority in formulating knowledge of the wind and pressure belts to Halley.[5]

In contrast to the observed simplicity of oceanic wind circulation was the complicated nature of wind directions over the adjacent land areas. Volney, experiencing difficulty in reducing the wind movements of eastern North America to a logical pattern, appealed for aid from many sources. Neither Von Humboldt nor Jefferson was able to give much help in this matter. The latter, in expressing sympathy with

[4] *Particulars relating to the navigation and trade of the East Indies,* MS Dec. 13, 1794, Boston Public Library.

[5] John Dalton, *Meteorological Observations and Essays.* London, 1793, p. 85. Von Humboldt says that the limits of the trades were first established by Dampierre in 1666. On p. 510 of Benjamin Franklin's essay "Of a circulation of humid air" (*Political, Miscellaneous and Philosophical Essays,* edited by B. Vaughan, London, 1779), one finds a simplified diagram of wind and pressure belts not essentially different from such diagrams in modern textbooks of physical geography.

Volney in his problems, states that he originally contemplated a countrywide study by supplying people in every county with necessary instruments, adding (perhaps with no intentional play on words): "This long-winded project was prevented by the war which came upon us and since then I have been otherwise engaged."[6]

The difficulty of analyzing the winds over the land, so apparent from reading Volney's final map on which the wind arrows point in strange and impossible directions, provided a great opportunity to the theorists who argued for this or that viewpoint. If all other things failed them, there were always the winds to rely upon —they could be caused to blow this way or that, or be made stronger or weaker according to the whims or wishes of the individual. In this respect the practical seaman who really knew and used the winds was far in advance of the landlubber; the oceanic winds and the currents which they set in motion lent themselves more readily to logical charting.

BEYOND THE COMMONPLACE

1. Instrumental data

By means of instruments, rain-gauges made at home, and thermometers of English manufacture, many individuals at widely distributed points made daily records of the common weather phenomena. The daily records were reduced to monthly means and averages with which the intelligent reader of today is familiar. A partial list of weather records, compiled during the latter part of the eighteenth century and a little later, is offered below. It is believed to be a partial list because so much manuscript material written during this period remains uninvestigated in this particular. For example, Professor Johnson, speaking of the South, has recently stated that "the reading of thermometers and barometers and the keeping of meteorological registers was of course an old Southern custom long before the days of the Smithsonian. Diaries and plantation ledgers not infrequently contain daily observations on the weather, covering a long period."[7] The names of those who made the observations form a distinguished list indeed. Their computations, reduced to monthly, seasonal, and annual averages, closely approach official weather records extending over the period during which the latter have been compiled. It may thus be inferred that these individuals, and those who had access to the material, possessed a fair working knowledge of the expectable climatic conditions at and near those places.

Only a brief discussion of this material seems called for here. Most remarkable is the record left by Dr. Edward A. Holyoke of Salem. This is perhaps the longest and most complete instrumental record made by a single individual in this country. Beginning his observations on January 19, 1754, when his thermometer arrived from London, he continued to record data until February 28, 1829, a year before his

[6] Letter to Volney, January 8, 1797, in *Volney et l'Amerique*. Johns Hopkins University Press, 1923, pp. 59–62.

[7] Thomas C. Johnson, Jr., *Scientific Interests in the Old South*. New York, D. Appleton-Century, 1936, pp. 71–72.

death at the age of 101. The data covering the period from 1786 to 1821 are the most complete and valuable. Dr. Enoch Hale edited this portion of the record and published some of the temperature data.[8] During the greater part of this period, Holyoke made from five to nine temperature readings a day, estimated the precipi-

PARTIAL LIST OF INSTRUMENTAL WEATHER RECORDS FOR THE ATLANTIC SEABOARD

Place	Period of Observation	Observer
Windsor, Nova Scotia	1794–1796	(1) Rev. W. Cochran
Rutland, Vermont	1781–1791	(2) Samuel Williams
Ipswich, Mass.	1781–1783	(3) Menasseh Cutler
Salem, Mass.	1754–1829	(4) Dr. E. A. Holyoke
Charlestown, Mass.	1792–1802	(5) Joseph Barrell
Cambridge, Mass.	1744–1747	(6) John Winthrop
Cambridge, Mass.	1780–1812	(7) Wigglesworth, Webber, Farrar
Stow, Mass.	1792–1804	(8) Jonathan Newell
Philadelphia (near)	1787–1800	(9) Mr. Legaux
Philadelphia	1792–1805	(10) David Rittenhouse, Benjamin Rush
Bucks County, Penn.	1773, 1777–1778	(11) Unknown
Williamsburg, Va.	1760–1762	(12) Francis Fauquier
Williamsburg, Va.	1780	(13) James Madison
Williamsburg, Va. (near)	1784–1793	(14) James Madison (President)
Warrenton, N. C.	1789	(15) Thomas Gloster
Charleston, S. C.	1750–1759	(16) Unknown
St. Augustine, Fla.	1767–1770	(17) William de Brahm

(1) *Transactions of the Royal Irish Academy,* IX, 1803: 133–145.
(2) MS Harvard College.
(3) *Memoirs of the American Academy of Arts and Sciences,* I, 1785: 331–371.
(4) *Ibid.* (data 1786–1829), I, 1833, New Series: 107–216, and MS at American Academy of Arts and Sciences in Boston.
(5) *Ibid.* III, 1809, New Series: 104–106.
(6) MS Harvard College.
(7) *Memoirs of the American Academy of Arts and Sciences,* III, 1809: 361–412.
(8) *Ibid.*, same volume: 122.
(9) Various numbers of the *Columbian Magazine.*
(10) MS American Philosophical Society.
(11) *Ibid.*
(12) *Travels through North America,* by the Reverend Burnaby.
(13) *Transactions of the American Philosophical Society,* II, 1786: 141–148.
(14) MS American Philosophical Society.
(15) *Ibid.*
(16) Lionel Chalmers, *An Account of the Weather . . . of South Carolina.* London, 1776.
(17) MS Harvard College.

tation, took readings of relative humidity from the hygrometer, minutely classified "the state of the weather" into twenty-five categories, and made observations of celestial phenomena—comets, meteors, auroral displays, and halos. The whole record fills at least 36 manuscript volumes. Dr. Holyoke and his thermometer be-

[8] The record did not terminate in 1829. According to Miss Mary Nichols of Danvers, Mass., a descendant, Holyoke's granddaughter continued the weather record on a less elaborate plan until 1880. At this point her son, Andrew Nichols, assumed the work, his observations continuing at the Danvers home until 1921. His reports were published in the *Salem News.* Miss Nichols, his daughter, continued the record until 1925.

came legendary in Salem, and, though it is stated by Samuel Breck that he had been but twice more than thirty miles from his home, he became a recognized authority on American climates. The principal defect in the Holyoke record consists in there being no observations at the normally coldest part of the day (before sunrise). In consequence of this the daily temperature range is less than it should be and the mean monthly temperatures are too high. Holyoke, recognizing this defect, applied a "correction factor" by the use of which the data may be brought more nearly into line with actual conditions.

Another significant record is that of Mr. Legaux, a farmer living 16 miles northwest of Philadelphia. This was the mysterious "Mr. L." to whom Brissot refers as being "very attentive to meteorology." The careful record of Legaux was summarized monthly in the numbers of the *Columbian Magazine*. It may be surmised that these summaries were consulted more eagerly than in these days of easily accessible records from official sources. The observations of Professors Wigglesworth, Webber, and Farrar, successors to Samuel Williams at Harvard, are also worthy of special comment.

2. *Phenological observations*

Our authorities realized that instrumental data provided at best only a formal climatic picture. Climatic conditions could also be witnessed in "the common operations of nature"—the dates of flights of migratory birds, and the seasonal growth of vegetation. Dr. Barton and others advocated investigations of the frondescence and florescence of plants as a practical and understandable means of elaborating the instrumental record.

Samuel Williams prepared several "views" of the climate of Rutland, Vermont: a view derived from instrumental records, and others secured from the leafing and flowering of vegetation. The results of his investigations follow:[9]

1. A view taken from the state of vegetation

	Buds	Leaves	Flowers	Matures
Gooseberry	Apr. 6	Apr. 16	May 9	July 20
Wild cherry	" 20	" 28	" 4	" 28
Apple	" 22	May 1	" 12	Aug. 18

2. A view taken from the fruits of the fields

	Sown	Flowers	Gathered
Flax	Apr. 16	June 25	Aug. 1
Spring wheat	Apr. 15	May 30	Aug. 15
Winter wheat	Sept. 1	May 26	Aug. 1
Oats	Apr. 20	June 7	Aug. 20
Peas	Apr. 16	May 26	July 1
Barley	Apr. 20	June 10	July 28
Corn	May 15	July 12	Oct. 1

Legaux, during the time he was recording data by means of instruments, observed the range in the dates of flowering and ripening of crops raised on farms near Philadelphia. For example, the annual ripening of grapes ranged from August 16

[9] *Natural and Civil History of Vermont*, 1794, p. 44.

to September 10, rye from June 31 to July 9, and wheat from July 4 to July 14. During the same period the absolute temperature range, as recorded by a shaded thermometer, was from 104.5° to –17.5° F.[10]

Similarly from 1797 to 1803, James Winthrop observed phenological operations in eastern Massachusetts, "that I might obtain a general knowledge of our climate and its variations."[11] A portion of his three columns of data is reproduced in the following table.

Winthrop's phenological data for Massachusetts

1. Native trees

	First leaves	First open flowers
Cherry	Apr. 19–May 4	Apr. 25–Apr. 29
Elm	May 4–May 11	Mar. 31–Apr. 18
Oak	May 10–May 15	May 16–May 23
Peach	Apr. 10–Apr. 30	Apr. 20–May 13
Poplar	May 2–May 10	Apr. 20–Apr. 24

2. First specimens of fruits and vegetables

Asparagus	Apr. 21–Apr. 30
Apricots	Aug. 12–Aug. 13
Cherries	May 29
Currants	June 25–June 29
Grapes	Aug. 22–Sept. 12
Peaches	Aug. 15–Sept. 6
Plums	Aug. 26–Sept. 3
String beans	June 15–July 3
Peas	May 28–June 12

3. *Observations on systematic climatology and storm types*

Native interest in atmospheric phenomena led to investigations of the origin of snow, dew, hail, and frost as well as to observations of the variable weather for which the seaboard country had already become justly famous. Dr. Franklin, with his usual sagacity, observed that "hailstones of the great weight we sometimes find them, did not probably acquire their magnitude before they began to descend." Vapor condensed in cold upper air strata drops earthward and "in descending both the drop of water and the grain of ice are augmented by particles of the vapour they pass through in falling, and which they condense by their coldness and attach to themselves."[12] That this theory was well established is shown by several published accounts of storms during which hail occurred in destructive sizes or amounts.[13]

[10] *Memoirs of the Philadelphia Society for Promoting Agriculture*, I, 1808, appendix.

[11] *Massachusetts Society for the Promotion of Agriculture*, 1804, p. 192.

[12] *Memoirs of the Literary and Philosophical Society of Manchester*, II, 1789: 373–374.

[13] The hail storm at Frederick Town, Md., May 16, 1803, *The Providence Phenix*, June 4, 1803. An impartial relation of a hail storm on the fifteenth of July and the tornado on the second of August, 1799 (Norwich, Conn., 1799); Account of a hail storm . . . on the 15th of July, 1799, perhaps never equalled by any other ever known, not even in Egypt; by Sherman Dewey, Walpole, N. H., 1799.

Noah Webster, having in mind multiple hypotheses regarding the origin of dew, carried on four experiments from 1790 to 1792 in order to decide which theory was correct. On the basis of hourly observations under a variety of conditions he concluded that dew is the result of condensation upon exposed objects slightly colder than the surrounding air. Dew, therefore, does not fall.[14]

Snow, it was explained to the reading public, is "a meteor formed by the freezing of the vapours of the atmosphere and being crystallized as it were differs from hail and hoar frost." Flakes are large or small depending upon the accession of parts in their descent: a thoroughly cold atmosphere produces flakes of small size, while under higher temperatures larger flakes are produced. Snow occurs in such an astonishing variety of configurations as to make it impossible of precise delineation.[15]

Samuel Williams was particularly interested in the phenomena of evaporation and conducted experiments to determine its rapidity under various conditions. Selecting the Merrimac River as a site for one investigation, he placed a floating open tube in the middle of the stream and a similar one suspended in the free air above. The evaporation from the floating tube was 1.15 inches in seven days, slightly less than that of the suspended tube. In the course of another experiment in which two vessels were used, one filled with water and the other with soil, he found that the evaporation from the soil was one-third that of the free water. To determine the rate of evaporation from plants, more elaborate equipment was required. Placing small specimens of apple, alder, spearmint, and clover in wooden boxes filled with soil and covered with a thin metal sheet containing apertures for the stems of the plants, he added water as required for the period of a month. Having weighed the added water and deducted the amount remaining, he found that from the plants 10,944 grains of water had evaporated, "amounting to about 43 cubic inches of water in thirty days. If these results apply to nature," he concluded, "evaporation from a forest surface for several months is greater than from a watery surface."[16] These conclusions greatly influenced his views regarding the extent of climatic change which had occurred due to the widespread clearing of land.

About the year 1740, while different individuals were observing a lunar eclipse at the instance of Dr. Franklin, the latter was led to form certain hypotheses regarding the movement of storms in the eastern part of the country. The reports which he received from these observers in different localities indicated that the eclipse was at some places wholly or partially obscured by clouds while elsewhere there was good visibility. On the basis of these reports and those "of other storms of the same kind," he was led to conclude that the beginning of the storms was "always later the farther to the northeastward."[17]

[14] "Experiments respecting dew, . . . " *Memoirs of the American Academy of Arts and Sciences*, III, 1809–1819, Part 1: 95–103.

[15] Observations on snow, *The Columbian Magazine*, III, 1789: 180–181.

[16] *Transactions of the American Philosophical Society*, II, 1786: 118–141.

[17] Letter in *The American Museum*, II, 1787: 76–77.

Thus were noted the characteristic movements of the weather-making cyclonic storms, though they were not known by this name for many decades thereafter. Nevertheless, the relationship between air pressure and storms had been observed for many decades, and that an easterly wind usually meant a rainy spell was a familiar tenet. In a part of the country maintaining such intimate connections with ocean navigation carried on by sailing vessels subject to weather hazards, one would expect commonsense knowledge of this type. The barometer or "the glass" was part of the standard equipment of vessels. It is thus not surprising to find accounts in popular magazines which show some knowledge of the mysteries of American weather. According to one account, an unknown author[18] observes that high and low pressures reflect ensuing weather—fair weather accompanying a rise in the mercury will continue unless a pronounced fall occurs. Foul weather is related to a lowering of the pressure. Moreover, weather effects are normally felt over a considerable extent of country at the same time: "Every one may be assured of this by comparing accounts kept at distant places of the play of the barometer." Thunderstorms, on the other hand, occur "without sensibly affecting the barometer," but "when a thunderstorm is attended with a fall of the barometer, its effect is much more extensive."

CONJECTURE AND BELIEFS

1. Contrasts of coastal and interior climates

In popular acceptance, and confirmed largely by scientists, was the idea that the climate of the trans-Appalachian country was warmer than that of the maritime fringe. This idea, proved fallacious shortly thereafter, stimulated much research and was perhaps significant in hastening the settlement of Ohio, Kentucky, and Tennessee during this period.

Volney's statement that "the temperature of the vallies of the Ohio and the Mississippi is warmer in proportion to three degrees of latitude than that of the maritime districts" was not based on original investigation; he was merely framing an accepted belief of the time. In so doing he gave to the statement an element of exactitude unwarranted by the information at hand.

This idea may be traced to a statement by Jefferson in his *Notes on Virginia* (1784) to the effect that certain species of birds and trees (the American parakeet and the catalpa) extended farther north in the interior than along the coast. Natural scientists, following Jefferson, elaborated this point to the extent that Barton felt justified in categorically announcing that "the southern trees and shrubs (that is, those vegetables which attain their greatest perfection in the southern climates of our continent, particularly the United States) are, in general, found much farther north in the western than in the eastern parts of our country. This fact seems to show, and the point is proved beyond any manner of doubt by thermo-

[18] "Curious observations on the weather and the use of the barometer when applied to improvements in agriculture," *Columbian Magazine or Monthly Miscellany*, March, 1787: 160–162.

metrical observations, that the western climate, in the same latitudes, is more temperate than the eastern."[19]

Daniel Drake seems to have been the first to take issue with this dictum.[20] He pointed out that while there are differences of temperature they relate more to its seasonal distribution than to the absolute quantity of heat. As a more reasonable explanation for the distribution of the parakeet in the interior (provided that were true) he called attention to the north-south flow of the Mississippi which tended to furnish similar habitats along its course. Birds could thus secure means of subsistence at points farther north than on the seaboard across which the rivers flow in a more east-and-west direction. Of course, the older theory persisted even among some of the scientists—Barton seems to have held it until his death—long after its fallaciousness had been exposed in this rather obscure publication. Possibly this belief in the greater geniality of the climate of the interior was held in exaggerated form by the general public.

2. Was the climate changing?

The possibility that the climate was in a process of change provided many with food for thought, and a few with a challenge to serious investigation. In the opinion of the majority, whose instrumental data, when used, rarely lent support, the climate was definitely changing. A number of eminent authorities, however, definitely expressed grave doubts, or by a judicious avoidance of the subject negatively indicated their doubtful position. Volney evaded the question altogether. Barton challenged the claims of the believers in climatic change in these words: "No very essential change has actually taken place in the temperature of the American climate, since the first discovery of the continent . . . or at least since the first settlement of the European colonies." However, if one thought otherwise, there were lines of procedure more appropriate than mere armchair speculation on the subject. He recommended, as suitable fields of investigation, inquiry among the Indians as to past climate, study of any possible changes in the leafing and flowering of vegetation, and the examination of the "annual circles of some of our largest trees." Recalling that the great Linnaeus "by examining an oak tree was able to distinguish with great certainty the hard winters of 1578, 1687, and 1709," he made a special plea for the study of annual growth rings. Within recent times Professor A. E. Douglass has developed this into a fruitful field of research.

Speaking more particularly of the climate of South Carolina, Drayton cautiously hints that "an opinion may be hazarded that [the climate] is in a state of progressive amelioration."

Samuel Williams, an advocate of climatic change, was led into this position through his researches into the rates of evaporation described above and other studies of the temperatures of open fields and forests. "On the 23rd of May, 1789," he writes, "I sunk a thermometer to the depth of ten inches below the surface of

[19] *Fragments of the Natural History of Pennsylvania*, 1799, p. vii.

[20] *Natural and Statistical View of Cincinnati.* See review of this in *The Port Folio*, 1816, I.

the earth . . . This was a level open field, used for pasture and grazing, and fully exposed to the sun. The same experiment was repeated in the woods. To ascertain the gradual increase of heat at each place, the observations were often repeated [from May to November]." He found the temperature of the pasture to be higher than that of the woods. "Thus the earth and the air are heated in consequence of their cultivation 10 or 11 degrees more than they would be in their uncultivated state." His students at Harvard annually heard him elaborate the theme that "In one century and a half this part of America has undergone a change which no country has ever passed through in so short a time . . . This cultivation of the country has been attended with *two remarkable effects upon its surface:* The waters have greatly decreased—and the surface has been much warmed and heated." Consequently the winters are much less severe, the weather is more "inconstant, variable and unsteady," there has been a decrease in the amount of snow, "the rains are more frequent now than they were formerly though the amount has not increased." Perhaps to reassure his listeners in the permanency of some elements he added that the winds had experienced no apparent change in direction or strength.

The more outspoken advocates of climatic change approached the subject theoretically, commencing with the assumption that the climate *had* changed beyond all dispute. "It is generally remarked by the people" or "in the opinion of the oldest settlers," this or that aspect of climate, it was stated, was now different from formerly. To provide a background of greater authority, writers would perhaps call attention to remarks on severe winters in the early travels of Peter Kalm, or in Wood's *New England's Prospect* or perhaps in Smith's *History of New York.* The works of Baron Lahontan, poor authority indeed, came in for their share of references. Time was, they said, when the Delaware and the lower Hudson were ice-blocked in mid-November; also, "in 1782 the harbour between Boston and Charlestown was frozen to such a degree that horses and sleighs passed over the ice for five or six days [February 2 to 10]." It was considered very important that Kalm was informed in 1749 "by the ancient people of Quebec" that the winters were at one time colder than they were then.

The theorists believed the supposed climatic change to have been due largely to the destruction of the forest cover. The reasoning by which this conclusion was reached was occasionally ingenious and often devious. Williams' reasoning has been outlined above. Hugh Williamson, a physician, attributed the supposed change directly to reduced wind strength and indirectly to forest clearing. This writer apparently fancied his remarks, for they were first published in 1770 and reproduced without essential change in 1772, 1789, and 1811,[21] the title somewhat altered after the colonies had become a republic. His theory called attention to the contrasts in the heating of land and sea, presumably resulting in winds flowing from land to

[21] "An attempt to account for the change of climate which has been observed in the middle colonies in North America," Aug. 17, 1770. Reproduced in: *Transactions of the American Philosophical Society,* 1789: 336–345, and in *The American Museum,* V, 1789: 229–233. In 1811 it appeared as a pamphlet printed by T. and J. Swords, New York. It was translated into French in *Observations sur Physique,* I, 1772: 430–436.

sea since higher pressures prevailed over the land. Now, should these temperature contrasts become more nearly equal, wind velocities would inevitably be diminished. It was not difficult for Williamson to find an adequate cause for increasing land temperatures (and thus weaker winds): through clearing large forested areas the temperatures over the land had elevated. The theorists who, in 1935, advocated the so-called "shelterbelt" in the Great Plains, would have found little comfort in Williamson's speculations on the wind-reduction effects of treeless areas!

Those who pondered the question were not unanimous in the opinion that the climate was becoming warmer. In the southern maritime section, some believed, the temperatures were becoming progressively cooler—it would scarcely do for it to be warmer. A writer of some academic standing observed that near Charleston orange trees, "though plentiful forty or fifty years ago, are now raised with difficulty. This is certainly a further proof of the change of our climate that we have just shewn to be eight degrees colder than it was sixty years ago."[22] A recent cold wave in early June which had destroyed gardens in Charleston, and the destruction of trees during the cold winters of 1766, 1779, 1786, and 1796, were taken as indications of a change of climate. In the winter of 1800, it was noted, snow "covered the earth six or eight inches in Charleston" and fell to an even greater depth in Brunswick, Georgia.

European writers expressed their amusement, not to say derision, over the insistence of the Americans on a measurable change of their climate. In fact a certain amount of ill feeling between the intellectuals on either side of the Atlantic had been engendered over the climatic issue. Various continental philosophers, headed by Buffon, Reynolds, and Robertson, had sought to show that the American climate was of such character as inevitably to lead to degeneration of man and beast. This suggestion nettled many patriotic Americans, who retaliated in kind. Sir Thomas Moore, whose odes were received in this country with poor grace, bore the brunt of much of this attack. A reviewer of his odes points out that "This country possesses physical capabilities of greatness and wealth without limits, and beyond all bounds; she has a territory which is spread out to an interminable extent, and fertile in every production conducing to the necessities and the gratification of animal nature; her navigable rivers, her capacious and convenient ports and the broad blue bosom of the Atlantic main, which connects her with the kingdoms of Europe, all give to her the means and the facilities of acquiring the most ample and the most permanent strength."[23]

With this background in mind, the comments of Dr. Johann David Schoepf, an observant traveler during the days of the confederation and a surgeon in the Anspach-Bayreuth troops in America during the Revolution, become more understandable. "The first and most striking comment of all travellers not only in the

[22] J. L. E. W. Shecut, "Climacteric constitution and medical sketch of Charleston (etc.)." *Medical and Philosophical Essays,* 1819.

[23] Review of the epistles and odes of Thomas Moore, in *The Monthly Register,* III, 1807: 91–106 (96).

northern but in the southern half of America, may be summed up in this statement: that all the experience as to climate and weather acquired on the three old continents cannot be in the least applied to the new one. Cold here has the upper hand . . . The credulous Americans have long flattered themselves that, by the great progress of cultivation and by the destruction of the forests of the country, their climate has for some years been rendered much milder and the severity of the winters been moderated. The past winter, however [1780], has disappointed these premature anticipations . . . North America is a land which is exposed to all the discomforts of the torrid and frigid zones, yet does not enjoy the advantages of either." He concludes his somewhat hostile remarks with a reference to the "pet theory of the Americans that the excessive cold of the northwest winds is due to the snow which lies so long in their boundless forests."[24]

THE SALUBRITY OF THE CLIMATE

Much of the interest in climate was stimulated by the ever-recurrent question of the true relation between climate and disease. The question was often asked: Is the climate (of a certain place) salubrious? Citizens of a part of the seaboard which had an unfavorable reputation in this regard were likely to rise in its defense. Already certain sections were popularly regarded as being unhealthful. Among these were the maritime plains of the far south and even Philadelphia, until recently the capital of the country. Still fresh was the memory of the "yellow fever" epidemic of 1792 in the metropolis of Pennsylvania, a scourge during which widespread, if temporary, evacuation by a terror-stricken people had occurred. The same disease struck Philadelphia again in 1797 and 1798, the death toll from August to November, 1798, being 3,521,—a figure including deaths from all causes.[25]

The low country of South Carolina and Georgia was widely presumed to be insalubrious by authorities and public alike. Hewatt, in 1779, agreed that "beyond doubt, the flat, maritime part of South Carolina and Georgia is an unhealthy situation, and the first settlers could scarcely have been cast ashore in any quarter of the globe where they would be exposed to greater hazards from the climate . . . Yet the country, low and unhealthy as it is, affords many advantages for commerce and navigation."[26] The epidemics of the southern coasts were most commonly referred to as "bilious remitting and unremitting fevers."

Many authorities, usually physicians, were still reiterating the traditional view that the cause of such diseases was the breathing of tainted air. The poisoned air arose from the exhalations of swamps under high temperatures, and invisible and insidious miasmata. However, during this period, thought was beginning to turn to what now seem to be more reasonable explanations. In the year 1798 we can see the older and the newer theory existing side by side. A group of Philadelphia

[24] *The Climate and Diseases of America During the Revolution.* Translated by James R. Chadwick. Boston, Houghton & Co., 1875 (31 pp.).

[25] "History of the yellow fever," *Philadelphia Magazine,* II, 1798: 68–78.

[26] Alexander Hewatt, *An Historical Account of the Rise and Progress of the Colonies of South Carolina and Georgia.* London, I, pp. 79–80.

physicians attributed the cause of the "yellow fever" there to (a) putrid exhalations from the gutters, ponds, and marshes nearby, and (b) noxious air emitted from the snow navigation inbound from the West Indies.[27] The physician Currie suggested, rather wordily, that "it may be fairly concluded that the causes of the unwholesomeness of low and moist situations in the summer and autummal months, is not owing to any invisible miasmata or noxious effluvia, which arise from the soil and lurk in the air, but to a very different cause, viz.: to a deficiency of the oxygenous portion of the atmosphere in such situations in consequence of vegetable and animal putrefaction in conjunction with the exhausting, debilitating heat of the days and the sedative power of the cold damp air of the nights."[28]

Progress in locating the source of such seasonal disorders was being made. A South Carolina physician was a leader in the newer point of view. Dr. David Ramsay, commenting on the impossibility of modifying the climate to a more healthful type, believed that "we may, nevertheless, attain the same object by combining convenience with health. The water of this increasing city [Charleston] will every day become more and more unfit for domestic use. . . ." The water consumed in Charleston was derived from shallow wells contaminated by "the filth which is collected on 597 acres of ground inhabited by upwards of fifteen thousand persons and which have been the receptacle of all the dead of the city for more than a hundred years." The remedy for this situation was obvious: the city water supply must be piped from a point outside the inhabited area. Ramsay recommended that the intake be in Goose Creek, then ten miles north of the city limits.[29] When this project was completed, Charleston's health problems were largely solved, but for many decades the public regarded it as an unhealthful situation. At almost the same time, Benjamin Latrobe drew up similar plans for Philadelphia and the engineering was soon completed.

It is altogether remarkable that these widely held beliefs about the unhealthfulness of certain districts were not particularly effective in restricting settlement within them. It does not appear that coastal South Carolina's population growth was affected by its presumed unhealthfulness, and Philadelphia continued its rapid growth regardless of its epidemics. Many a traveler noted this apparent paradox. In the following passage Isaac Weld speaks truly except, perhaps, in his estimate of the toll of disease in west-central New York. "It is very remarkable . . . yet the Americans, when they are about to change their place of abode, seldom or ever consider whether the part of the country to which they are going is healthy or otherwise, at least they are scarcely ever influenced in their choice of a place of residence either by its healthfulness or unhealthfulness. If the lands in one part of the country are superior to those in another in fertility, if they are in the neighborhood

[27] A "snow" was an American type of three-masted brig. *Proofs of the Origin of the Yellow Fever in Philadelphia and Kensington in the Year 1797.* Philadelphia, Academy of Medicine, 1798, p. 6.

[28] *Proceedings of the American Philosophical Society,* IV, 1799: 127–142 (p. 135).

[29] Extract from a memoir of the late epidemic fever in Charleston, *South Carolina Weekly Museum,* II, 1797: 577–579.

of a navigable river or situated conveniently to a good market, if they are cheap and increasing in value, thither the American will gladly emigrate let the climate be ever so unfavorable to the human system. Not a year passes over but what numbers of people leave the beautiful and healthy banks of the Susquehanna River for the Genesee country where nine out of ten of the inhabitants are seized, during the autumn, with malignant fevers."[30]

The subject of climate and health must not for this reason be lightly cast aside as unimportant in geography. In the first place it is seen that this period was one of transition from the older belief in the direct cause of disease by atmospheric conditions, to the more modern viewpoint that seasonal fevers were somehow borne by water and food supplies. In the second place the problem led to many detailed studies of local environments. The papers were written in a field then styled "medical topography," and were published under the auspices of medical groups and societies. Perhaps of little value from the medical standpoint (except as revealing progress in technical knowledge), the papers contain valuable regional descriptions. Had the health question been less momentous, few of them would have been prepared or published.

THE TYPES OF CLIMATE

The authorities, while realizing that there were broad climatic differences along the Atlantic seaboard, did not precisely define the limits of the types. Volney was content roughly to identify three climatic regions: (1) the coldest climate—New England and eastern Canada; (2) the temperate climate of Pennsylvania and Maryland; and (3) the hot climate from Virginia southward. Bernard Romans at a much earlier time (1776) had subdivided East Florida into two types, using the St. Marys River as the boundary between the "tropical" and "subtropical" sections. Throughout the seaboard, annual rainfalls were so ample as to be above a critical level and the contemporary authorities saw little significance in differences in its seasonal distribution. Precise regional classifications were left to a later age.

Volney made no special use of tabulations of climatic data; his climatic subdivisions were simply those which had been traditionally accepted (and still seem adequate to the general public) and which agreed with his own observations. That he was a keen observer stood him in good stead. He recognized a most critical line of demarcation when he noted that "the parallel of Potowmack, or more exactly that of the Patapsco, forms, in this respect, a distinguishing line." The reader who consults modern climatic regions maps (Koeppen and Thornthwaite) on which subdivisional lines are located by the most rigid adherence to accumulated data, will see that Volney did remarkably well without them. Taking the sleigh as the principal clue to the distribution of two types of seaboard climate, he observed that in the northern "dominion of snow" the sleigh is "to be seen before every farmer's door" until the traveler crosses the Patapsco River (Baltimore), "after which he will see that vehicle no more."

[30] Isaac Weld, Jr., *Travels*. London, 1799, p. 299.

IV

A PLEA FOR GEOGRAPHY, 1813 STYLE

THE following essay, written over a century and a quarter ago, may provide interesting and instructive reading to present-day geography teachers for, in many respects, its theme is a timeless one. A vigorous support of geography, particularly as a subject suitable for the college curriculum, the essay was composed during a period of spirited intellectual interest in that subject but long before collegiate standing was assured to it. The essay was prepared in October, 1813, as a contribution to a debating group, the Aurius Ramus Society, of Harvard College. Its author was Jared Sparks, then an upperclassman at Harvard, of which institution he became president in 1849, but better known to modern scholars as a biographer and historian. It is a pity that this prefatory note may not be climaxed by stating that Sparks' youthful dreams were fulfilled by the addition of geography to the curriculum during his five-year term as president, but the facts will not permit us to make such a good story. This might argue that Sparks was indulging only in rhetoric when he prepared his essay, or that he later changed his mind; on the other hand one may gather from his writings that he maintained a deep interest in geography throughout his long and useful life. Some of the stoutest supporters of geography, we realize, are and have been identified with other subjects. This was particularly true in the early days and it was largely through their efforts and pleas, such as are here illustrated, supported by lay opinion, that geography first became established in the curriculum.

Without further ado, and without laborious annotation and editorial improvement, we will permit this college student of another generation to have his say in a paper which he entitled simply

GEOGRAPHY*

Few studies are more useful, few more easily attained, and none more universally neglected, than that of geography. The vast importance of this branch of study is sufficiently obvious to any one who takes the least interest in the passing events of the world, or who receives any pleasure in pondering the revolutions of mighty empires, and their consequences, recorded in history. Bacon so highly estimated the value of this science, that he dignified it with the appellation of divine. "Geography," says he, "is a heavenly study, but an earthly subject." . . . "Without a knowledge of this science," says Bennet, "our reading would be a confused mass, without order, light, or perspicuity." Lord Chesterfield used to say that "geography and

* This essay forms a twelve-page manuscript item in the voluminous Sparks Collection (132, Misc. Papers, Vol. I, 1808–1814) and is published with permission of the Harvard College Library. Mr. Clifford K. Shipton, custodian of Harvard University Archives, contributes the information that the Aurius Ramus Society was a college debating group. Other factual material regarding Sparks at Harvard was secured from H. B. Adams, *Life and Writings of Jared Sparks* (1893) and Samuel E. Morison's *Development of Harvard University*, Cambridge, 1930.

chronology are the two eyes of history." Were I permitted to carry the allusion still further, and make a very odd figure, I would consider history an allegorical Polypheme, whose eye should be Geography. Nor would the student in history, destitute of light afforded by geography, be in a much better condition than Polypheme, groping among the rocks of Sicily, with his *"ingens lumen ademptum."* It is not easy to conceive how it is possible to make any valuable progress in the study of history without a previous knowledge of this science. He who attempts to study history without this knowledge, is much in the same condition as him who attempts to read an unknown language, while he is yet ignorant of the greatest part of the words of which it is composed, or the painter, who fancies he can draw a fine countenance before he has learnt to sketch the outlines of a likeness.

While we are ignorant of the boundaries of the countries about which we read, their population, their general aspect and the bearings and distances of important places, what definite idea can we form of their individual and relative importance, or their political relations one with another? Although we may read long histories of short campaigns, and marvel much at the valorous exploits of a few mighty warriors, yet have we any more real and satisfactory knowledge from reading these accounts, than we should derive from a romance, unless we have clear and accurate views of the geographical situation of the places where these transactions happened? We cannot, without this, have any just notions of the comparative merits of commanders in conducting their armies, or the probable advantage or disadvantage that will result to either party from the losing or gaining a battle. It was the custom of Gen. Moran, even long after he came to our country, to trace with the minutest precision on maps of a large scale, every movement of the armies in Europe.

It is necessary for us to know, not only the contiguous territories of kingdoms and empires, but also their possessions and dependencies in various parts of the earth. The treaties between governments, which in modern times are among the most important events recorded in history, are scarcelv intelligible to any one ignorant of geography. Let such a person read the treaties of Campo Formio, of Luneville, or of Amiens, and say whether his views of them are not exceedingly confused, & whether he has any just conceptions of the probable effect that the conditions stated in them will have upon either party. In fact, the necessity & utility of this science in a historical point of view, are too obvious to need illustration.

In commerce it is no less important. No one ought to be better acquainted, than the commercial man, with the whole chart of the globe in its minutest divisions. Every sea, every bay, harbor, island, and navigable river, ought to be as familiar to him as the streets in which he daily passes, or his favorite walks in his garden. The soil and climate of different countries, and the commodities of each, with which the most advantageous trade could be carried on, should be well known to him. Were he ignorant of these, he would have but limited views of the probable consequences of a voyage to any particular part of the world, and the dangers and casual losses that are to be apprehended.

The political occurrences of the day, which are taking place in every part of the world, render a knowledge of geography of the highest consideration to politicians. It is, however, notorious, that no class of people are more uniformly ignorant on this point than they. It will scarcely be presumed, nevertheless, that this ignorance is a proof that geography is of no importance to them; for it will not be readily granted that universal ignorance of any branch of science is an evincive proof of its inutility. It requires but a slight acquaintance with the conversation of our ephemeral politicians to discover the gross ignorance which prevails among them of geography, and the laughable errors they are perpetually falling into for this reason. Were this ignorance confined to common-place politicians alone, it might be endured, but that it should discover itself in those who have been honored with the appellation of statesmen, is scarcely sufferable. A ludicrous blunder, made a few years ago by an honorable member of congress, is still fresh in the minds of many. A bill was introduced in which some circumstances respecting our trade to India were involved. After some debate in the house, he arose with apparent emotion, and expressed his astonishment that the house should manifest any disposition to enter into the meditated measures, and

gave as an insurmountable objection the impossibility of our vessels passing to India without being molested by the Algerine cruisers. Whether the honorable gentleman thought that a canal had lately been cut through the deserts of Suez or that the Algerines lived in the W. Indies, South America, or the west coast of Africa is impossible to conjecture; it is sufficient to add that he was interrupted in his speech by a general burst of laughter from every quarter of the house.

Few studies have a more effective tendency to extend our views and free us from unreasonable national prejudices and contracted habits of thought, than that of geography. What, but a long rooted prejudice and kept up by a total ignorance of geography, could have caused so great surprize in the Chinese mandarins, when they learned from the maps of the Jesuits, that the empire of China, which they had thought as extending nearly over the whole earth, occupied but a very small portion of it? The story is well known which tells of the astonishment with which Alcibiades was filled when Socrates informed him that Attica was not so large as the whole world besides.

In the above remarks, the importance of geography has been wholly deduced from the consideration of the term in its original acceptation, *the description of the earth's surface*. But if we take into view those subjects which are now generally embraced under it, we shall find the inducements for becoming intimately acquainted with it vastly multiplied and enlarged. Manners and customs of people; various grades of society in human life; the comparative influence of different modes of life upon the happiness of mankind; the apparent effect of different climates upon the human mind & character, constitute a mass of knowledge in the highest degree interesting and useful to everyone who is convinced that "the proper study of mankind is man." Geography, in its modern dress, not only embraces these subjects, but treats extensively upon those collateral branches of general science, natural history, mineralogy and botany. Although the union of these sciences with geography affords additional inducements & superior attractions to its study, yet it may be doubted if any real additional advantage ultimately arises. It is evident that, in studying a multiplicity of subjects thus thrown together, the mind will be withdrawn in a measure from each, and therefore will make little permanent improvement in either. This objection, however, is in a great measure obviated in the excellent geography of Mr. Pinkerton, in which the different subjects are distinctly arranged in separate chapters in such order that they may be omitted or read as may be thought proper.

If we reflect upon the vast importance of this department of science in almost every sphere & every situation in life, nothing can be more surprizing than that it should be so universally neglected. None can be of more easy attainment to every capacity. It requires no vigorous exertion of thought, no extraordinary effort of intellect to become in a degree master of it; yet how many do we see engaged in the active employment of life, and those, too, whose education in other respects is by no means deficient, perpetually betraying the grossest ignorance of geography. This is the more to be wondered at, as there is no science whatever which comes so often into use in common life. Many columns of our daily gazettes would be absolutely unintelligible to one who is not very well acquainted, not only with the general divisions of the earth's surface, but also the geographical position and local importance of all the principal places in every country. . . .

To all classes of people is geography important, but to students it is doubly so. They are supposed, when they leave the University, and go into the world, to have treasured up & made themselves familiar with such knowledge as will be most useful to them in life; and as none is more so than geography, if they are ignorant of that, they will unavoidably be forever exposed to serious mortifications among those of inferior talents and far less acquirements than themselves. To be ignorant of what it is supposed one ought, from the advantages he has had, to know, argues stupidity or culpable idleness, and who is ambitious to be thought a dunce or a lounger? It is a circumstance scarcely to be accounted for, that geography is not in some places admitted to occupy a more conspicuous place in a course of liberal education. That it

should be anywhere totally excluded in a system of education is absolutely unaccountable. The student will spend his days in laborious exertion & grow pale over his midnight lamp and perhaps ruin his health and constitution, distracting his mind with the metaphysical jargon of Locke, learning the edifying names of minus, plus, sine, tangent and radius, and plodding with singular patience through a series of mathematical problems, theorems & algebraical process, which will give him no other ideas than those of a line, an angle, and the names a, b, and x and perhaps y; and will spend years in conjugating and declining Latin & Greek verbs and learning the names, and reading the wonderful exploits of heathen deities & demigods. These are the studies which employ the undivided attention of our students, and these are the studies which, of all others, they find least use for in the common concerns of life.

I would by no means insinuate a belief of the inutility of these studies when they receive only their due proportion of attention. They are concomitant branches which are necessary to the accomplishment of a finished education, but they should not be suffered to demand so much attention as to exclude others of still more importance.

It has been said, it is true, that geography is so easily attained, students may become perfectly masters of it while in college, without instruction; and, therefore, it is not necessary to introduce it into the system they are to pursue. However possible this is, it requires no argument to prove that it is very seldom, if ever, the case. It is believed that most of us can testify from experience that students are not very strongly inclined to impose upon themselves the acquisition of any branch of study in addition to those embraced in the general system. They will have at the time no very strong motives to induce them, as they will be led very justly to suppose that their courses of study will include all that is most important for them to learn.

Ignorance of no branch of knowledge is so readily discoverable as of geography. A mistake in assigning the proper situations of a river, city or province, argues ignorance not only of those places themselves, but of the whole section of the globe in which they are found. If we should answer to an inquirer that Constantinople is in Egypt or that Ispahan is in India, we should not only manifest an ignorance of the situations of Constantinople & Ispahan, but that we know nothing of Turkey, Egypt, Persia or India. . . .

A late elegant writer has said that "no study is so attractive as geography." If a consciousness of pursuing such studies as will be productive of the greatest advantages in life be a source of pleasure, sufficient has been said to show the decided claims of geography. And, indeed, if nothing further be considered than the immediate pleasure derived from the mere exercise of study, it may be doubted if any branch have very superior claims. Dr. Watts has laid it down as an excellent rule in all our reading, "never pass over a word without knowing its meaning." This rule holds with peculiar force in geography. An immense advantage will be found to result to any one who will keep maps & gazetteers by him, and recur to them for the name of every place whose situation he does not know. He will by this exercise in a short time obtain a fund of geographical knowledge, and seemingly without any exclusive attention to the study. Besides, we derive secret satisfaction from the constant acquisition of our knowledge, and a consciousness that we pass over nothing without understanding it.

THE CLIMATES OF THE ARGENTINE REPUBLIC ACCORDING TO THE NEW THORNTHWAITE CLASSIFICATION

J. J. BURGOS* AND A. L. VIDAL**

TRANSLATED FROM THE SPANISH
BY MAJOR ARCHIE M. McFARLAND AND LT. COLONEL ROBERT R. OSBORN***

I. OBJECT AND BASES OF CLIMATIC CLASSIFICATIONS

THE purpose of a climatic classification is to characterize climatic regions in terms of those principal elements, such as temperature and precipitation, which are the most decisive in the determination of the landscape of the earth's surface. Moreover, it attempts to develop the similarities which these great climatic units bear to each other and their relation to their principal causes; the effect of latitude and of atmospheric and oceanic circulation, in opposition to geographic accidents.

Climatic classifications owe their origin to phytogeographic descriptions. The physiognomic descriptions of plant associations are related to the first descriptive maps of the distribution of temperature and rain, and in this connection we should cite the valuable contributions of De Candolle (1855), Grisebach (1866), Drude (1887), and Schimper (1898) that include the analysis of the diverse plant associations of the world with relation to the principal climatic elements which determine them. Wladimir Köppen, contemporary of the phytogeographers mentioned, was the first to attempt a rational classification of the major climatic groups, taking as a basis the phytogeographical manifestations which they determine and adopting a terminology and symbolism similar to those used by previous authors (Köppen, 1884 and 1900). In later works this author sought an appropriate formula for expressing the relative value of rain, since its absolute value is not considered representative of its action over the earth's surface. In these studies he recognized the importance of a knowledge of evaporation in distinguishing between humid and dry climates. Being unable to measure evaporation, he developed as his indices relations between precipitation and temperature, weighing both in such manner that the resulting indices would correspond to the boundaries between the actual vegetation types. Since then, many authors have concerned themselves with this problem, attempting to improve upon the primary concepts established by Köppen. Penck

* Professor of Climatology and Agricultural Phenology of the Faculty of Agronomy of La Plata and Chief of the Division of Agrometeorology of the National Meteorological Service of Argentina.

** Technical Assistant, National Meteorological Service of Argentina.

*** U.S.A.F., Johns Hopkins Laboratory of Climatology, Seabrook, New Jersey.

(1910), De Martonne (1926), and Thornthwaite (1931) can be cited with many others making studies of this nature, but in our judgment all of these works are rather in essence climatic descriptions of phytogeographical or simply geographical regions. Their indices, primarily for expressing the relative value of precipitation, are theoretical and these as well as those of Köppen generally evaluate rain and temperature as deduced from their action on vegetation.

The new Thornthwaite classification (1948) has the advantage over the others previously proposed of being independent of indices deduced from the appearance of the vegetation and of using exclusively climatic values for expressing the relative value of precipitation.

The climatic classification thus is given a real basis and a new orientation since the indices that it uses are based upon climatic elements. While the appearance of vegetation integrates all the changes of the climatic processes in past epochs, its form in continual evolution, because of other important factors such as geologic and edaphic, may be out of harmony with the actual climatic process. For this reason, all conclusions concerning the basis of an equilibrium with the present climate may carry an implicit error.

In the new Thornthwaite climatic classification (1948), this author introduces into climatological knowledge a new element, potential evapotranspiration, which serves to determine the relative usefulness of precipitation. We admit, with the author, that this system of climatic classification could be improved, especially with respect to the evaluation of thermal efficiency or by means of a yet better agreement in the determination of potential evapotranspiration and in the moisture balance, but we consider that it represents a great advance over the systems proposed up to the present.

The classes of climate thus determined have been very useful in the description of natural regions and in the geographic problems connected therewith, such as the classification of the great soil groups and of vegetation. In the special problems of agricultural climatology, on the other hand, they have only served for general orientation, since the fixed requirements of the crops and of their diseases and cultural operations require a more detailed analysis of the climatic elements than is necessary in climatic classification. In those cases, we consider that the climatic classification is not much more useful than the classification of large groups of soils or phytogeographic regions.

However, as has been said previously, the climatic elements on which this new classification is based can be very helpful in problems of agricultural meteorology and in agricultural practice. Among these we can enumerate the study of the regimen of drought, soil erosion by water or wind, the systematizing of irrigation, the planning of cultural operations, comparative and special agrometeorological studies, as well as bioclimatic and biometeorological studies more general than those previously listed.

II. POTENTIAL EVAPOTRANSPIRATION AND ITS MEASUREMENT

Potential evapotranspiration has been defined by Thornthwaite as the quantity of water that would be evaporated from the surface of the soil and transpired from

the plants if the soil contained an optimum content of moisture. The optimum content of soil moisture is that which is retained by the soil solely by capillary force after the soil has been saturated; that is to say, its moisture equivalent or field capacity.

Real evapotranspiration, on the other hand, has been defined by this author as the quantity of water that actually evaporates from the soil and transpires from the plants in a given interval of time and may be governed by the actual moisture content of the soil.

Evapotranspiration is thus the inverse of rainfall and its knowledge permits us to establish the degree to which water requirements are satisfied by precipitation in any particular region. Potential evapotranspiration has been called also, water need, which means the quantity of water that is needed by the soil in order to maintain permanently the optimum degree of moisture.

The measurement of potential evapotranspiration can be made in satisfactory manner using the evapotranspirometer of Thornthwaite (Burgos, 1950) which consists of a tank of soil covered by herbaceous vegetation, in which the water table is maintained at a depth of 50 cm. Unfortunately, few measurements have been made of this element; we can only refer to measurements made during the past few years in California and New Jersey, in Chapingo, Mexico, and in Toronto and Norman Wells, Canada.

The measurement of real evapotranspiration still is hampered by instrumental difficulties and only by the application of the theory of air mass interchange (Thornthwaite and Holzman, 1942) is it possible to have a direct measurement of this element. Lysimeters and water balance, which consider the potential evapotranspiration, permit its calculation in indirect manner.

With the limited available data on evapotranspiration, Thornthwaite has prepared a general formula by means of which it is possible to obtain its unadjusted values; that is to say, for a month of 30 days each with twelve hours of possible solar radiation. According to this formula which is a potential function within certain limitations, a direct relationship exists between the logarithm of temperature and the logarithm of unadjusted potential evapotranspiration. (Thornthwaite, 1948.)

Once the monthly values of unadjusted potential evapotranspiration have been obtained, it is necessary to correct them for the duration of the month and the length of day, using Table 1. (In this work the original table of Thornthwaite has been extended to the southern hemisphere thus providing corresponding values for our country.) In order to accomplish this correction, the figures of Table 1 should be multiplied by each value of monthly unadjusted potential evapotranspiration, thus attaining the adjusted value of potential evapotranspiration. Adding the twelve values, the annual value is obtained. For latitudes above 50°S, the same correction factors which correspond to 50°S latitude are used. The steps involved in the computation of potential evapotranspiration are illustrated in Table 2 by the data of Azul in the state of Buenos Aires.

III. POTENTIAL EVAPOTRANSPIRATION IN ARGENTINA

The computations of potential evapotranspiration in Argentina were made from temperature data of the meteorological stations of the National Meteorological Service which have observations extending over ten years and in the majority of

TABLE 1

MEAN POSSIBLE DURATION OF SUNLIGHT IN THE SOUTHERN HEMISPHERE EXPRESSED IN UNITS OF 30 DAYS OF 12 HOURS EACH

Lat.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5	1.06	.95	1.04	1.00	1.02	.99	1.02	1.03	1.00	1.05	1.03	1.06
10	1.08	.97	1.05	.99	1.01	.96	1.00	1.01	1.00	1.06	1.05	1.10
15	1.12	.98	1.05	.98	.98	.94	.97	1.00	1.00	1.07	1.07	1.12
20	1.14	1.00	1.05	.97	.96	.91	.95	.99	1.00	1.08	1.09	1.15
22	1.14	1.00	1.05	.97	.95	.90	.94	.99	1.00	1.09	1.10	1.16
23	1.15	1.00	1.05	.97	.95	.89	.94	.98	1.00	1.09	1.10	1.17
24	1.16	1.01	1.05	.96	.94	.89	.93	.98	1.00	1.10	1.11	1.17
25	1.17	1.01	1.05	.96	.94	.88	.93	.98	1.00	1.10	1.11	1.18
26	1.17	1.01	1.05	.96	.94	.87	.92	.98	1.00	1.10	1.11	1.18
27	1.18	1.02	1.05	.96	.93	.87	.92	.97	1.00	1.11	1.12	1.19
28	1.19	1.02	1.06	.95	.93	.86	.91	.97	1.00	1.11	1.13	1.20
29	1.19	1.03	1.06	.95	.92	.86	.90	.96	1.00	1.12	1.13	1.20
30	1.20	1.03	1.06	.95	.92	.85	.90	.96	1.00	1.12	1.14	1.21
31	1.20	1.03	1.06	.95	.91	.84	.89	.96	1.00	1.12	1.14	1.22
32	1.21	1.03	1.06	.95	.91	.84	.89	.95	1.00	1.12	1.15	1.23
33	1.22	1.04	1.06	.94	.90	.83	.88	.95	1.00	1.13	1.16	1.23
34	1.22	1.04	1.06	.94	.89	.82	.87	.94	1.00	1.13	1.16	1.24
35	1.23	1.04	1.06	.94	.89	.82	.87	.94	1.00	1.13	1.17	1.25
36	1.24	1.04	1.06	.94	.88	.81	.86	.94	1.00	1.13	1.17	1.26
37	1.25	1.05	1.06	.94	.88	.80	.86	.93	1.00	1.14	1.18	1.27
38	1.25	1.05	1.07	.93	.87	.80	.85	.93	1.00	1.14	1.19	1.27
39	1.26	1.06	1.07	.93	.86	.79	.84	.92	1.00	1.15	1.19	1.28
40	1.27	1.06	1.07	.93	.86	.78	.84	.92	1.00	1.15	1.20	1.29
41	1.28	1.06	1.07	.93	.85	.77	.83	.92	1.00	1.15	1.21	1.30
42	1.28	1.07	1.07	.92	.85	.76	.82	.92	1.00	1.16	1.22	1.31
43	1.29	1.07	1.07	.92	.84	.75	.81	.91	1.00	1.16	1.22	1.32
44	1.30	1.08	1.07	.92	.83	.74	.81	.91	.99	1.17	1.23	1.33
45	1.31	1.09	1.07	.92	.82	.73	.80	.90	.99	1.17	1.24	1.34
46	1.32	1.10	1.07	.91	.82	.72	.79	.90	.99	1.17	1.25	1.35
47	1.33	1.11	1.07	.91	.81	.71	.78	.89	.99	1.18	1.26	1.36
48	1.34	1.11	1.08	.90	.80	.70	.76	.89	.99	1.18	1.27	1.37
49	1.35	1.12	1.08	.89	.78	.68	.75	.88	.99	1.19	1.28	1.40
50	1.37	1.12	1.08	.89	.77	.67	.74	.88	.99	1.19	1.29	1.41

cases over twenty years. These computations were used to prepare a map of mean annual potential evapotranspiration. This map must be considered a preliminary sketch until verified experimentally (figure 1).

The lines of equal annual potential evapotranspiration follow approximately

the course of the isotherms. The resulting lines parallel the meridians in the regions next to the Andean foot-hills, and in the open part of the country they assume an east-west direction characteristic of the isotherms. In Patagonia they run approximately in the diagonal direction.

The maximum values of annual potential evapotranspiration are recorded in northwestern Formosa and northeastern Salta where a maximum of 1,200 mm is attained. From here, the values decrease toward the south and west to a value of 500 mm in Tierra del Fuego and the northwest of Santa Cruz. The reduction of potential evapotranspiration due to elevation is observed in the ridges of Cordoba and San Luis, and the effects of the combination of the elevation of the terrain and the marine current of the Malvinas is observed in the southeastern part of the province of Buenos Aires where values under 750 mm are recorded.

TABLE 2

COMPUTATION OF POTENTIAL EVAPOTRANSPIRATION OF AZUL (BUENOS AIRES) BY THE T–E METHOD

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature °C	21.2	19.8	17.7	13.4	10.2	7.3	7.2	8.1	10.7	13.4	16.9	19.1	13.8
I	8.91	8.03	6.78	4.45	2.94	1.77	1.74	2.08	3.16	4.45	6.32	7.61	58.24
Unadjusted Potential Evapotranspiration (mm)	98	89	76	51	35	22	21	25	37	51	71	84	
Adjusted Potential Evapotranspiration	122	93	80	48	31	18	18	23	37	58	84	107	719

IV. MOISTURE BALANCE

The knowledge of the potential evapotranspiration of a particular location which has precipitation records permits determination of its annual moisture balance. From this balance it is possible to determine the quantity of water actually evaporated from the soil and transpired from the plants, the quantity of water stored by the soil and the surface and sub-surface runoff in these localities.

Since evapotranspiration and precipitation are two independent climatic elements, their annual course hardly coincides in any locality. Consequently, in some places there are periods when the necessity for water is satisfied by rainfall, and other periods when there is scarcity of rainfall. Thus, there will be months with sufficient water and months in which water excess or deficiency are recorded in manifest form. Also those extreme cases could occur in which, during each month of the entire year, precipitation surpasses water needs or vice versa.

When a dry period is followed by heavy rain which exceeds evapotranspiration losses, there is a water surplus which does not begin to run off until the soil moisture has risen above field capacity. The quantity of water which the soil will retain is designated the "water storage capacity." It varies between certain limits

FIG. 1. Mean annual potential evapotranspiration.

depending on the soil depth and texture, and the distribution and extension of the root system of the plants, but in general terms, can be said to approximate a water layer of 100 mm depth. If the precipitation exceeds this quantity, and at the same time is not depleted by evapotranspiration, surface runoff and infiltration into the lower layers of the subsoil occur.

If a period of excessive rain is followed immediately by a period in which precipitation is less than the potential evapotranspiration, the soil begins to lose its moisture because of the action of evapotranspiration, and the storage of available water diminishes until it reaches the minimum compatible with plant life, the wilting coefficient. The moisture lost by the soil prior to this time is called the "available soil moisture" in the moisture balance and corresponds, as in the preceding case, to a layer of approximately 100 mm of water.

In order to compute the mean annual moisture balance of a locality for which data of monthly values of potential evapotranspiration and rainfall are available, the following procedure is followed: select, if possible, a period with rainfall substantially greater (or less) than the potential evapotranspiration. In this case 100 mm (or 0 mm) is assigned in the column "useful water storage" for the last month of the period. In proceeding with the calculation for the following months, add the precipitation of the month being considered to the value of useful water storage of the preceding month, and from this total, which constitutes the available water, subtract the potential evapotranspiration for the month, so that the new value of useful water storage is obtained. If the value of useful water storage is greater than 100 mm, only the value of 100 mm will be provided for this month, since this is the maximum condition of water storage in the soil. The excess over 100 mm will be the "water surplus" of the month considered.

It can be anticipated that the sum of available water storage of the preceding month and the precipitation of the month considered might be less than the potential evapotranspiration of this month; that is, that the demand is greater than the available water. In this case, a "moisture deficiency" would result, and the useful water storage will fall to zero. The magnitude of the water deficiency will be the number of millimeters necessary to complete the potential evapotranspiration.

Once values for all the months of the year have been calculated in the manner described, the computation of the moisture balance could be verified if by adding the value of useful water storage of the eleventh month to the precipitation of the twelfth month, the value of 100 mm (or 0 mm) which was fixed previously is obtained. If this is not the case, the calculation should be continued in such manner that in the second cycle of calculations the values are adjusted until at the end the last figure obtained coincides with the first.

The variation of useful water storage which is shown in Table 3 is obtained from the difference between the storage of the previous month and of the month being considered, and has a negative sign when the storage is decreasing.

In order to calculate the real evapotranspiration it must be observed if the precipitation of the month being considered is greater than the potential evapotran-

TABLE 3 (1)

MOISTURE BALANCE
AZUL (BUENOS AIRES)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Potential Evap.	122	93	80	48	31	18	18	23	37	58	84	107	719
Precipitation	70	95	100	83	53	38	41	45	66	72	88	80	831
Storage Change	-52	2	20	35	22	0	0	0	0	0	0	-27	
Storage	21	23	43	78	100	100	100	100	100	100	100	73	
Actual Evap.	122	93	80	48	31	18	18	23	37	58	84	107	719
Water Deficiency	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Surplus	0	0	0	0	0	20	23	22	29	14	4	0	112
Moisture Ratio	-0.42	0.02	0.25	0.73	0.71	1.11	1.28	0.96	0.78	0.24	0.05	-0.25	

spiration. If this is the case, the real evapotranspiration has the same value as the potential. If the precipitation is less than the water need the values of the precipitation and of the change of water storage are added without taking signs into account, and the result gives the real evapotranspiration of that month.

The "moisture ratio," which expresses the relative humidity or aridity of a particular month, is obtained by dividing the difference between the precipitation and potential evapotranspiration by the potential evapotranspiration, thus:

$$\frac{p-e}{e}$$

TABLE 3 (2)

MOISTURE BALANCE
BARILOCHE (RIO NEGRO)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Potential Evap.	97	80	68	43	27	15	15	19	29	51	64	86	594
Precipitation	30	29	65	87	159	192	164	127	84	36	50	43	1,066
Storage Change	-28	0	0	44	56	0	0	0	0	-15	-14	-43	
Storage	0	0	0	44	100	100	100	100	100	85	71	28	
Actual Evap.	58	29	65	43	27	15	15	19	29	51	64	86	501
Water Deficiency	39	51	3	0	0	0	0	0	0	0	0	0	93
Water Surplus	0	0	0	0	76	177	149	108	55	0	0	0	565
Moisture Ratio	-0.69	-0.64	-0.04	1.02	4.09	11.80	9.93	5.68	1.89	-0.29	-0.22	-0.50	

Positive values of the moisture ratio indicate an excess of precipitation and negative values indicate a deficiency.

V. MOISTURE BALANCE OF THE ARGENTINE REPUBLIC

The separate elements which integrate the moisture balance of the Argentine localities of Bariloche and Azul are included in Table 3. This table shows the individual values of each month as well as the corresponding total annual values. Because they are considered to be of much practical interest, maps of Argentina with isolines of water surplus and deficiency have been constructed.

The water surplus in our country (figure 2) is confined to a relatively small region which embraces the Selva Misionera,[1] the Parque Mesopotamico, the eastern part of the Estepa Pampeana, and a narrow eastern fringe of the Parque Chaqueño. Another region of notable surplus, although of the same small extent in relation to the rest of the country, embraces the sub-Antarctic Forests, principally the subformation of the Foresta Valdiviana. Some excess is recorded also in the portion which constitutes the Selva Tucumano-Oranense and the Malvinas Islands.

In the eastern region of our country the average annual water surplus attains a maximum of 700 mm in the Selva Misionera and diminishes to the west and south, reaching zero along a line which passes one hundred kilometers to the west of the Rio Paraná, approximately paralleling its course, and extending through the center of the province of Buenos Aires as far as Bahía Blanca. In the Selva Tucumano-Oranense the maximum surplus reaches 200 mm, and in the Bosques Subantarcticos in the region of the Foresta Valdiviana, a surplus of 500 mm is reached.

The lack of appreciable water surplus in a large part of the country explains the absence of important rivers running from east to west, with the exception of the few which are fed by thawing snow. At once, it is clear that the eastern zone of water surplus, whose principal characteristics have been described, corresponds with the dense river network of Corrientes, Entre Rios, and Misiones. The distribution and magnitude of the water surpluses have indicated the regions where the erosion caused by runoff is a problem, or could become one, and where remedial efforts should be concentrated.

Water deficiency is notable in our country (figure 3) and only very limited regions are found to be free of it. The Selva Misionera, the western margin of the Rio Paraná in a fringe of 50 to 100 km extending to the Rio de la Plata, the southeastern portion of the Estepa Pampeana and the Malvinas Islands do not record water deficiencies in their normal mean values.

The centers of maximum aridity of the country are found in the San Juan province and in the plains region of La Rioja and Catamarca provinces where the deficiency varies between 700 and 800 mm. The Valles Calchaquies have an annual deficiency of 600 mm and the central northern part of Patagonia has values over

[1] The nomenclature used in designating phytogeographic regions of the Argentine Republic has been taken from Hauman, et al (1947); the English equivalents are the following: (1) selva, rain forest; (2) parque, transition from closed forest to parkland; (3) bosque, woodland; (4) estepa pampeana, grassland; (5) monte, chaparral.

FIG. 2. Mean annual water surplus.

FIG. 3. Mean annual water deficiency.

600 mm. It is interesting to note that the Selva Tucumano-Oranense and the sub-Antarctic forests record a deficiency which varies between 0 and 200 mm.

The knowledge of the magnitude and annual distribution of water deficiencies, in addition to being the best available index of aridity, constitutes a valuable aid in irrigation planning, because it shows with a great exactitude not possible until today, the distribution and amounts of water need.

It will be useful to point out here that the dry character of our country with small surplus and notable water deficiency in part is due to the fact that the winter season is a period of water consumption rather than of storage. On the other hand, in comparable latitudes of the northern hemisphere the winter temperatures are markedly lower, reducing or annulling the evapotranspiration, and aiding the accumulation of water in the forms of ice and snow. This reserve provides a spring abundance of soil moisture and runoff to the rivers which drain the watershed.

We consider this fact as one of the principal causes which determine the absence of broad leaved or mixed mesophytic forests in the middle latitudes of our country. In the northern hemisphere this type of forest is found in the middle latitudes in regions with excesses of water greater than 200 mm where podzolic soils are found in which the optimum moisture occurs with greater frequency.

On the other hand, the greater extent of territory with water excesses which vary around 100 mm, and which at the same time experience less deficiency, explains the formations of the steppe and the prairie. These formations, with a shallow root system, correspond in general to shallow soils in which the optimum moisture condition of the upper layers alternates with dry periods of short duration. We believe also that this distinctive characteristic of the Argentine climate preserves the fertility of its soils which are not noticeably affected by the continuous leaching by excessive water.

In figure 4, the moisture balance of some Argentine localities including three rain forest type formations is presented. Concepcion de la Sierra, of the Selva Misionera type; Villa Nouques, of the Selva Tucumano-Oranense; and Bariloche, of the Foresta Valdiviana.

In the individual diagrams of these localities (figure 4), it can be seen that in the Selva Misionera, the water surplus is the most considerable, and that if during the summer the precipitation does not balance the evapotranspiration, a climatic deficiency of water does not exist because the soil water storage is able to satisfy the requirements of evapotranspiration. In the other two localities, on the other hand, the water need is not satisfied during the hot season either by the precipitation or by the soil moisture storage and thus there is here a short period of water deficiency. This deficiency occurs in spring in the Selva Tucumano-Oranense and in summer in the Foresta Valdiviana.

We have included three examples of arid climates: Rivadavia, San Juan, and Colonia Sarmiento which represent the xerophytic vegetation of the Chaqueño savanna, the Monte formation, and the Patagonia steppe. In the first of these the

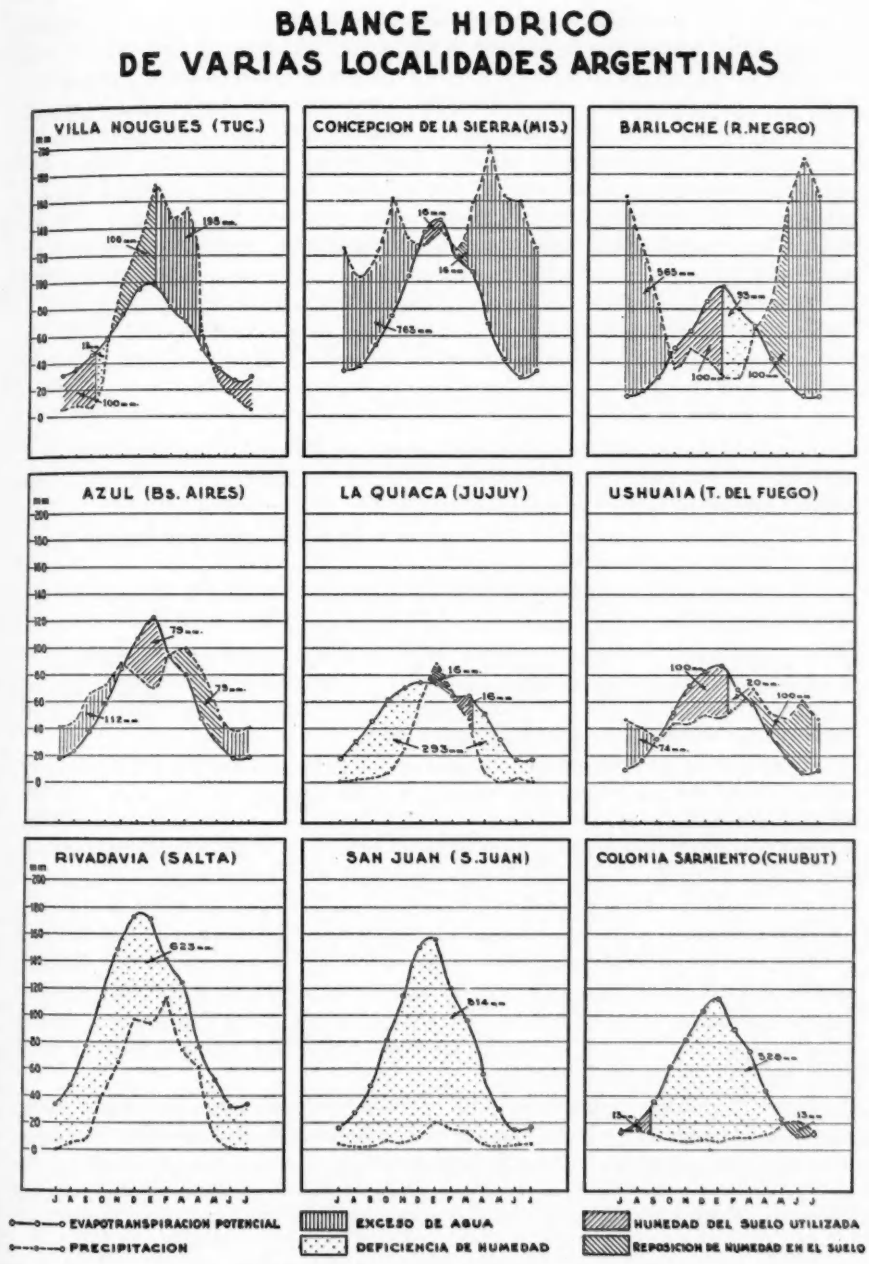

FIG. 4. Moisture balance of various Argentine localities.

precipitation, of considerable quantity, does not satisfy the demands of the evapotranspiration; in the second, where the maximum aridity of our country is recorded, the very limited precipitation leaves a higher balance of water deficiency, and in the third, the light winter rains are not sufficient to restore the soil moisture storage.

Of the three remaining localities, Azul is a typical example of the prairie or steppe of the Pampa, where the climatic march of evapotranspiration follows approximately that of precipitation. However, slight irregularities of both leave a balance of 112 mm of excess in winter and spring, while in the summer the water demand consumes the precipitation and part of the storage water of the soil without exhausting its reserve. In this region a climatic deficiency of water does not exist.[2]

The other two localities exemplify microthermal climates: La Quiaca, with a considerable deficit of water and no excess, and Ushuaia with an excess of 74 mm in the coldest months and some deficiency in the months of January and February.

VI. VERIFICATION OF THE COMPUTATION OF THE CLIMATIC ELEMENTS

It will be useful here to explain the experimental verification which has been made of the calculations of evapotranspiration from which, together with precipitation, the moisture budget is deduced.

The details of the method of computing the potential evapotranspiration can be seen in the comparison of the observed and calculated values which Thornthwaite used in developing his formula (Thornthwaite, 1948). Moreover, this author (Interim Reports Nos. 4–11, Laboratory of Climatology, Johns Hopkins University) has compared the calculated potential evapotranspiration and that observed daily since 1947 with evapotranspirometers installed in New Jersey. Sanderson (1948) has made a similar comparison in Toronto and at Norman Wells, Canada. In all these cases, the result has been very satisfactory.

Thornthwaite (1948) verified the calculated water balance by comparing the computed evapotranspiration of a series of weather stations in the U. S. with the total water used by crops (irrigation plus precipitation) in the same localities. Computed and observed values are very similar and their differences in only one case out of 13 exceed 4 per cent. This same author (Thornthwaite, 1946) found a series of relations for various North American localities that showed a satisfactory agreement between actual soil moisture, observed by taking soil samples and drying them in an oven, and that calculated by the method of the water balance. Sanderson (1948) established a comparison between the observed run-off in various valleys in Canada and the excess of water calculated by the method of potential evapotranspiration, and the results obtained permit concluding that the method gives acceptable results for those latitudes.

In addition to the comparisons of the method discussed above, the author recognizes the interest that would be given the experimental determination of evapo-

[2] Since the monthly climatic values constitute a mathematical abstraction of the variable weather elements, it does not mean that a region without climatic deficiency of water will not experience deficiency with a certain frequency in the course of time.

transpiration in the equatorial and polar regions. For polar regions, records are available from evapotranspirometers installed at Norman Wells at 64°30′ north latitude and 125°20′ west longitude.

In our country, for lack of experimental potential evapotranspiration data we have attempted to verify the calculation of the water balance by the comparison of calculated values of soil moisture and those observed in our agrometeorological stations. Results of this comparison, which we consider acceptable, can be seen in figure 5. It must be taken into account that the determination of soil moisture is from individual samples, which admit to error of measurement, both because of the heterogeneity of the soil and because of inadequacies in laboratory technique.

We have obtained a good verification of the agreement of the water balance, by considering the excess of water calculated and the loss observed in the valley of the Rio Quequen (calculated, 60 mm; observed, 49 mm). Unfortunately, the values from the Rio Salado do not permit a similar comparison, as the extensive net of drainage canals from the province of Buenos Aires diverts a good part of the water that should belong to this river.

The data in Table 4 show in the same way the comparison between the consumption of water from irrigation in some valleys having arid and semiarid climates and the deficiency calculated by the water balance method.

TABLE 4

Region	Water Deficiency (Mean Value in mm)	Water Consumed by Irrigation		Observations
		Year	mm	
Santa Rosa (S. Luis)	300–350	1938	402	
		1939	360	
Famatina (La Rioja)	750	1938	848	
		1939	745	
Arauco Y C. Barros (La Rioja)	700–750	1938	1176	Rainfall much less than normal
		1939	832	
San Carlos Salta	650	1938	1070	Rainfall much less than normal

The comparison of the vegetation regions in the Argentine Republic with the maps of water surplus and deficiency further confirms the validity of the method under discussion. We hope, in the near future, to rely upon direct observations of potential evapotranspiration from an extensive net of observation stations in order to subject this method to definite proof.

VII. THE MOISTURE REGIONS IN THE ARGENTINE REPUBLIC

The new climatic classification of Thornthwaite (1948) is based, as the former, on the distribution of moisture effectiveness and thermal efficiency, which are the elements that principally determine plant life.

Thornthwaite has proposed a moisture index in order to establish the moisture

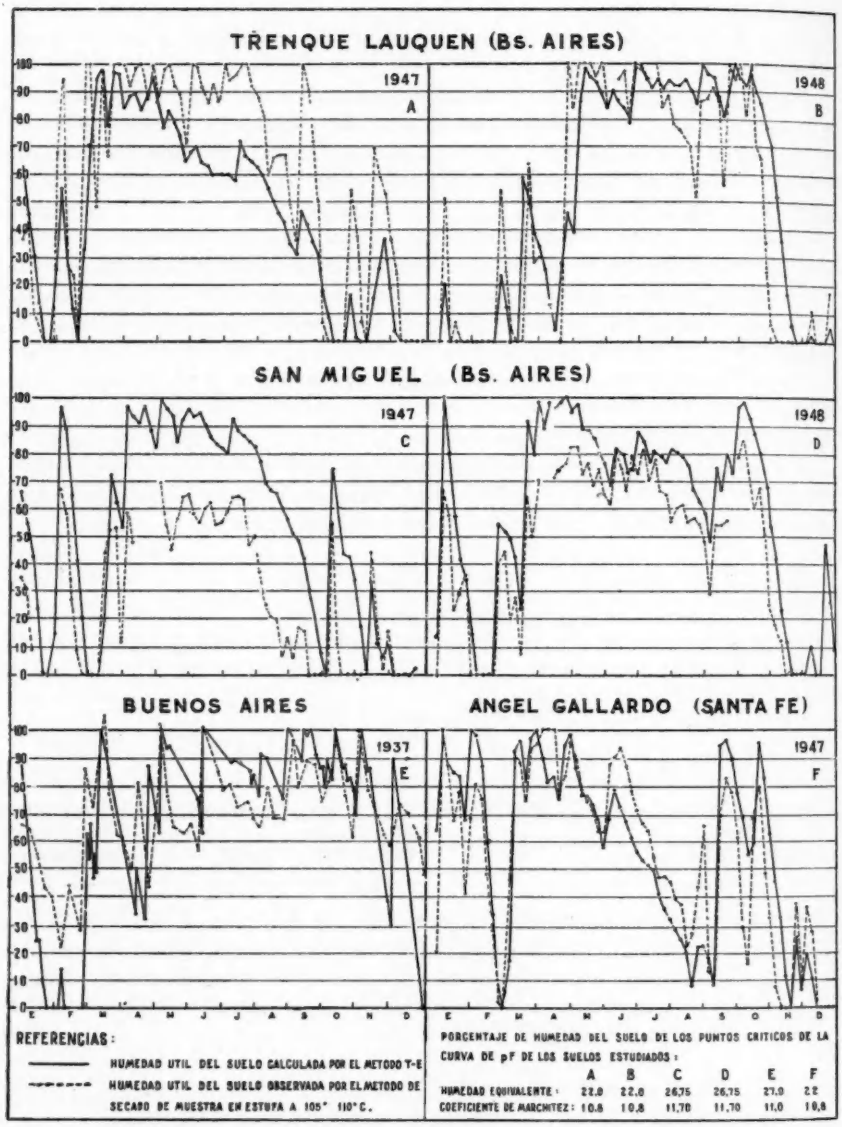
TRENQUE LAUQUEN (Bs. AIRES)
1947
A
1948
B
SAN MIGUEL (Bs. AIRES)
1947
C
1948
D
BUENOS AIRES
1937
E
ANGEL GALLARDO (SANTA FE)
1947
F
E F M A M J J A S O N D
REFERENCIAS:
HUMEDAD UTIL DEL SUELO CALCULADA POR EL METODO T-E
HUMEDAD UTIL DEL SUELO OBSERVADA POR EL METODO DE SECADO DE MUESTRA EN ESTUFA A 105° 110°C.
PORCENTAJE DE HUMEDAD DEL SUELO DE LOS PUNTOS CRITICOS DE LA CURVA DE pF DE LOS SUELOS ESTUDIADOS:
A B C D E F
HUMEDAD EQUIVALENTE: 22,0 22,0 26,75 26,75 27,0 22
COEFICIENTE DE MARCHITEZ: 10,8 10,8 11,70 11,70 11,0 10,8

FIG. 5. Comparison of calculated soil moisture with that observed at several agrometeorological stations.

regions. The index integrates the annual water balance that we have previously described into one value. Its computation is obtained by subtracting 6/10 of the aridity index from the humidity index. The index of aridity is expressed by:

$$\frac{100 \times \text{water deficiency}}{\text{water need}}$$

and the humidity index is equal to:

$$\frac{100 \times \text{water surplus}}{\text{water need}}$$

from which the evaluation of the moisture index results.

$$\frac{100 \times \text{water surplus} - 60 \times \text{water deficiency}}{\text{water need}}$$

The arid climates have negative moisture indices and the humid climates, positive. The aridity index is reduced to 60% because it is assumed that the perennial vegetation can utilize the moisture from deeper layers of the soil; the depth of this layer is considered to be approximately 1 meter in the calculation of the water balance.

The moisture index so determined is not completely founded upon the type of vegetation that corresponds to the climate, and remains subject to the free play of water surplus and deficiency. The distinct climatic types that result from the possible moisture indices with their limits are the following:

Climatic Type	Moisture Index
A Perhumid	100 and above
B_4 Humid	80 to 100
B_3 Humid	60 to 80
B_2 Humid	40 to 60
B_1 Humid	20 to 40
C_2 Moist subhumid	0 to 20
C_1 Dry subhumid	−20 to 0
D Semiarid	−40 to −20
E Arid	−60 to −40

In the Argentine Republic, figure 6A, according to the data that we have, the perhumid type does not exist, but the humid B_4 is found in a small portion of the country in southern Neuquen and northern Chubut. In the localities from which we have records, the extreme eastern part of Misiones approaches this limit (Concepcion de la Sierra, 79.7).

In the northeastern portion of the Argentine Republic, and toward the southeast, the climate goes by steps from the humid types B_3, B_2, B_1, through the moist subhumid C_2 and the dry subhumid C_1. All this portion was included in the humid type climate, C_f in the classification of Köppen (1931), which in the northern hemisphere corresponds to a climate of hygrophyte and mesophyte forests; in the humid type B and subhumid C of the former classification of Thornthwaite (1931) and in the arid and semiarid type according to the aridity index of De Martonne (1926).

If we analyze the new distribution of the moisture regions according to Thorn-

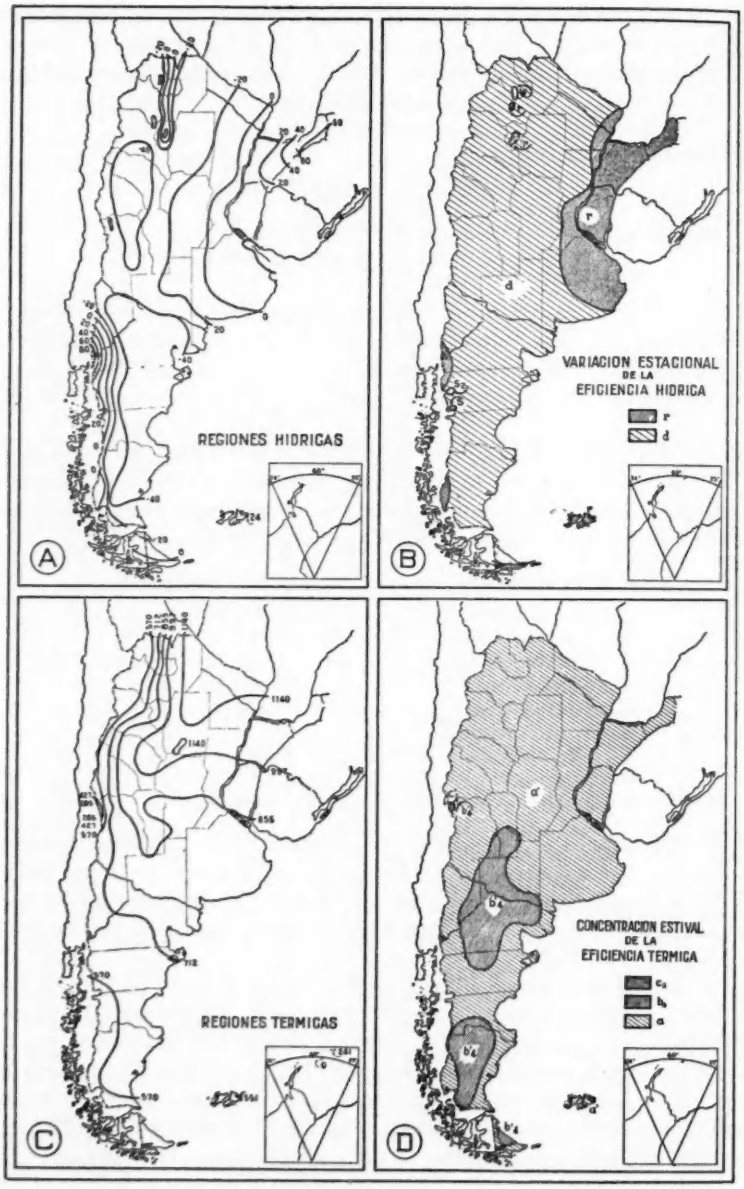

FIG. 6. A. Moisture regions
B. Seasonal variation of effective moisture
C. Thermal regions
D. Summer concentration of thermal efficiency.

thwaite, we find a climatic reason for considering part of the right border of the Rio Paraná and the Rio de la Plata in the phytogeographic formation of the Parque Mesopotamico, as Burkart (Hauman et al, 1947) does, and for considering northeastern Corrientes in a phytogeographic unit with the territory of Misiones, as some phytogeographers have suggested.

The Estepa Pampeana is included in the moist subhumid type C_2 in the eastern portion and the dry subhumid C_1 in the west. This would explain the climatic reason for its lack of forests and its physical similarity to regions such as the "Grass Belt" of the U.S.A. and Canada that have this type of climate in the northern hemisphere at corresponding latitudes.

The line of zero moisture index is intended to mark the division between the pedalfer and pedocal soils. To the west of this line, in the central part of the Argentine Republic, the arid types of climates are found. The dry subhumid C_1, which embraces the central part of the Parque Chaqueño and the western Estepa Pampeana, is a transitional type towards the typically dry climates.

The semiarid type D embraces the region of the xerophytic forests of the Parque Chaqueño, the eastern portion of the formation of the Monte where the xerophytes are the common tree elements, and the Bosque Pampeano.

The increase of precipitation and the decrease of evapotranspiration beginning in the mountain system of Aconquija and the first Andean foothills of northwest Argentina, cause the reappearance of the more humid climates, such as the dry subhumid, the moist subhumid and the humid B_1. These last probably include the extension of the Selva Tucumano-Oranense.

To the west of these mountain systems to which we have referred, because of the drying effect of the descending winds from the north and east in the season of greatest precipitation and also greatest water need, the arid type of climate E is found, where the lowest moisture index of the country is recorded. In this type of climate are included part of the deep pass of Humabuaca, the Calchaquies valleys and the flat portion of the provinces of Catamarca, La Rioja, San Juan and Mendoza. The formation that corresponds to this type of climate is the Monte Occidental, with xerophytic shrub vegetation.

To the south of the Rio Colorado we have a similar picture but reversed in the distribution of moisture regions. The positive moisture values descend rapidly to negative values from the west to the east, with the descent of terrestrial relief. In a range of approximately 150 km, the types go by steps from B_4, B_3, B_2, B_1, to C_2. Most of the eastern half of Patagonia falls within the arid type E with indices less than -40. The south portion of the Territory of Santa Cruz belongs to the semiarid type D, northern Tierra del Fuego to dry subhumid C_1, southern Tierra del Fuego to moist subhumid C_2, and the Malvinas Islands to the humid B_1.

This climatic distribution is in perfect agreement with the distribution of natural vegetation in the southernmost part of our country. The forms of the most extreme xerophytes of the central part of Patagonia are replaced by others less adapted

to the lack of water. In the extreme southeastern Santa Cruz the association with delicate grasses appears, and with it the possibility of raising cattle. These conditions are accentuated in the north of Isla Grande of Tierra del Fuego, in whose south portion, because of the increase of effective moisture and the higher latitude, the conditions of the moist subhumid forests reappear.

The Malvinas Islands should have the features of the Bosques Magallánicos, based upon the moisture efficiency of its climate (B_1), but due to the extraordinary force and frequency of the wind, its vegetation is herbaceous and shrub-like. The floristic composition of the vegetation of these two areas is very similar. (Skottsberg, cited by Hauman, et al, 1947.)

VIII. SEASONAL VARIATION OF EFFECTIVE MOISTURE

In order to express the seasonal variation of the moisture effectiveness, Thornthwaite (1948) takes into account the magnitude of the index of aridity in the moist climates (A, B, C_2) and that of the index of humidity in the dry climates, according to the following values and characteristics:

	Moist Climates (A, B, C_2)	Aridity Index
r	Little or no water deficiency	0 to 16.7
s	Moderate deficiency of water in summer	16.7 to 33.3
w	Moderate deficiency of water in winter	16.7 to 33.3
s_2	Large deficiency of water in summer	more than 33.3
w_2	Large deficiency of water in winter	more than 33.3

	Dry Climates (C_1, D, E)	Humidity Index
d	Little or no water surplus	0 to 10
s	Moderate surplus of water in winter	10 to 20
w	Moderate surplus of water in summer	10 to 20
s_2	Large surplus of water in winter	more than 20
w_2	Large surplus of water in summer	more than 20

In accordance with the preceding classification, the dry climates of the greater part of our country have very little seasonal variation in their lack of effective moisture and fall within the group d, of little or no water surplus (figure 6, B).

The moist climates of the northeast portion of the country fall in the group r with little or no water deficiency. The moist climates of northwest Argentina take the characteristic r in the provinces of Tucuman and Salta and w in the province of Jujuy. This last characteristic which is defined as moderate water deficiency in winter, occurs in the province of Jujuy, as a deficiency in spring. The moist climates of southwest Argentina take the characteristic r in the part closest to Chile, in southern Neuquen and northern Chubut and in western Santa Cruz. In the moist subhumid region of this sector, we encounter localities with moderate deficiency in summer, such as in Rio Pico (characteristic s); and with large water

deficiency in summer, such as in Esquel (characteristic s_2). The moist subhumid climates of southern Tierra del Fuego and the Malvinas Islands are characterized by little or no water deficiency (characteristic r).

IX. THERMAL REGIONS IN THE ARGENTINE REPUBLIC

In this new climatic classification the potential evapotranspiration which contains an expression of the length of day and of temperature is proposed as an index of thermal efficiency. The thermal climatic types and their index limits are as follows:

Index of Thermal Efficiency (mm)		Type of Climate
	E′	Frost
142		
	D′	Tundra
285		
	C'_1	– Microthermal
427		
	C'_2	
570		
	B'_1	
712		
	B'_2	– Mesothermal
855		
	B'_3	
997		
	B'_4	
1140		
	A′	Megathermal

The Argentine Republic (figure 6C) has the megathermal type of climate in Formosa, eastern Salta, western Chaco, northeastern Santiago del Estero and in a small part to the west of the extreme northern mountains of Cordoba above the Salinas Grandes. The megathermal type is not synonymous with tropical. In these regions frosts are frequent in winter, and for this reason even when irrigation is available, many typically tropical plants cannot prosper therein.

The mesothermal climates embrace almost all the rest of the country and their various types extend along borders that follow approximately the direction of the isotherms. The Estepa Pampeana is included in the mesothermal type B'_2.

The microthermal climates have scant representation in our country, since the type C_2 extends through western Chubut, western and southern Santa Cruz, Tierra del Fuego, Malvinas Islands and the greater part of the Andean desert.

As a Tundra climate D′ we can cite the Cristo Redentor and as a perpetual frost climate E′ the high snowcapped peaks of the Andes, the Islas Orcadas del Sud and Antarctic Argentina.

X. SUMMER CONCENTRATION OF THERMAL EFFICIENCY

The summer concentration of thermal efficiency includes the following types and their corresponding percentages of concentration:

Summer Concentration Percentage	Summer Concentration Type
	a′
48.0	
	b'_4
51.9	
	b'_3
56.3	
	b'_2
61.6	
	b'_1
68.0	
	c'_2
76.3	
	c'_1
88.0	
	d′

The small annual temperature variation that is recorded in all the Argentine Republic (figure 6D) causes very few types of climate with summer concentration of thermal efficiency. This is due to the fact that the greater part of the country corresponds to the type a′ and only its more continental portion that embraces eastern Mendoza, southern San Juan, western La Pampa and central Rio Negro falls in the type b'_4. In the mesothermal climates B'_1, and the microthermal climates where the summer is very short, the summer concentration of low thermal efficiency is relatively high. Therefore, central Santa Cruz and northern Tierra del Fuego, correspond to the type b'_4 and the localities around Cristo Redentor and Puente del Inca, to c'_2 and b'_4.

XI. CRITICAL ANALYSIS OF DISTINCT SYSTEMS OF CLIMATIC CLASSIFICATION IN THE ARGENTINE REPUBLIC

Various papers have been prepared dealing with the climatic classification of the Argentine Republic.

Davies (1902 and 1910) proposed a climatic division that only results in a meteorological description of political-geographical regions.

The various works of Köppen (1923 and 1931) and that of Köppen-Geiger (1936) concerning the climates of the world, include maps of South America showing its climatological system. Knoche and Borzacov (1947, 145–163) made a fundamental criticism of its adaptation to the geographic reality of the country, and described the system of Knoche of "monthly climates" which does not permit making a definitive climatic synthesis.

In figure 7, we present various climatological systems applied to the Argentine Republic for comparison with regard to the evaluation of the moisture regions.

We have traced the moisture regions of De Martonne by means of his most re-

cent formula for the index of aridity (De Martonne, 1947) that derives from the average of the annual index of aridity and that of the driest month. The types of climate of Köppen we have taken from the work of Knoche and Borzacov, cited above.

All these systems are based on a weighing of the humidity, according to the relation that exists in nature between precipitation and the water consumed by evaporation, but in the calculations of the moisture indices temperature is used in place of evaporation. That is to say, they follow the premise established by Köppen in his first papers on climatic classification, when he said "Precipitation alone does not determine the moisture content of the soil nor permit distinguishing if a climate is moist or dry. Here, the time and type of precipitation as well as the intensity of the evaporation are decisive." (Köppen, 1900, p. 605). "In the rainy climates the effects of the water from rainfall are different according to the temperature." (Köppen, 1923, p. 110.) "Very few measurements of the moisture content of the soil are available, but it is made sufficiently evident by the plant cover and by the rainfall-runoff relations of the land, in springs and streams. For this the rainfall alone cannot serve as a measure, since it depends on how fast the fallen water again evaporates. Quite a few measurements of evaporation are available for several countries, but they are not satisfactory for a climatic survey since the apparatus, and much more the ground, gives entirely different values of evaporation depending on protection from wind and sun, etc. But instead of evaporation we can use the air temperature in connection with rainfall to obtain an approximate expression for the desired value—the moisture condition of the land." (Köppen, 1923, p. 112.)

The systems of Köppen and De Martonne exemplify what can be expected when the moisture factor is based on theoretical formulae in which the temperature alone is used as the direct measure of the evaporation. The system of Thornthwaite (1931) shows that the moisture balance or "precipitation effectiveness" results from the use of the temperature as a variable, determined experimentally from evaporation from free water surfaces; the system of Thornthwaite (1948) shows that the moisture balance is obtained by taking into account the potential evapotranspiration from the soil and from the vegetation, and the capacity of retention of the soil, in which case the temperature is only one of the experimentally evaluated variables that determine the potential evapotranspiration.

Using the types of climate by Köppen (figure 7A), it is not possible to separate the moisture regions, inasmuch as the criteria for establishing the limiting values between them will vary according to the thermal region that they define. But the fact that such limiting indices have been deduced from the vegetation regions by world-wide comparison permits unbiased judgment of its more general value of application. In the utilization of this system in America by Russell (1926) in California, Van Royen (1927) in the eastern portion of North America, and Ackerman (1941) in North America, there has been little conformity to the natural limits of the vegetation types.

In our country, we may refer to Köppen's own opinion that "the entire La Plata

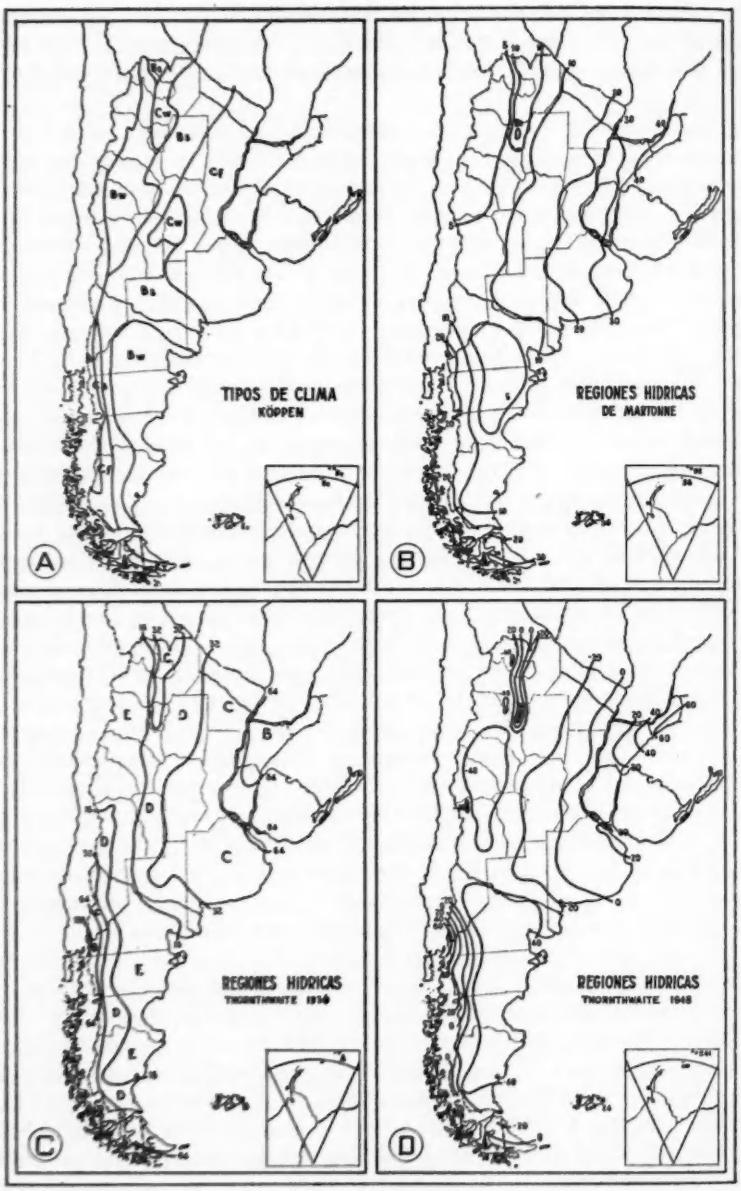

FIG. 7. A. Types of climate, Köppen
B. Moisture regions, De Martonne
C. Moisture regions, Thornthwaite, 1931
D. Moisture regions, Thornthwaite, 1948.

region presents similar difficulties of classification in the over-all system of climate; for it must be considered as 'humid mesothermal' according to its rainfall, but precipitation is in the form of showers distributed on so few days that the lack of trees on the Pampas is no doubt strongly influenced by the scarcity of water; according to the frequency of rainfall one would have to classify it as steppe climate; it lacks a true rainy season, which if it existed would make possible growth of trees with much less yearly rainfall, especially if it came in the cooler season. In fact on the average on a rainy day in the Pampas 15–20 mm fall, while in the steppes of southern Russia, the dryness of which also is often attributed to the rain coming in showers, the average fall on a rainy summer day is only 7 mm. A similarity exists in the same latitude in North America, where in Arkansas and surrounding areas 12–15 mm fall per rainy day, for a moderate total rainfall and for only about 10 rainy days per month." (Köppen, 1923, p. 125.)

If we examine the map we see that the climate C_f, humid mesothermal, which according to Köppen "is distinguished by luxuriant forests of high trees, wherever tree growth is not restricted by strong winds or adverse soil conditions, as on the seacoasts and in the moor," (Köppen, 1931, p. 164), embraces a great expanse in our country whose phytogeographic landscape includes the formation of rainforest, xerophyte woods and steppe. The C_w mesothermal climate, dry in winter, that ought to correspond to the vegetation of low forest or xerophyte shrub, embraces the Selva Tucumano-Oranense and the xerophyte brushes of the mountains of Cordoba. Finally, the C_s mesothermal climate, with dry summer or windy climate, that corresponds to the climate of the Mediterranean and the central portion of Chile, in our country embraces the northern portion of the sub-Antarctic forests that some authors have defined as rainforest.

Probably Schmieder's error in considering the Pampeana steppe as a man-made grassland, which may be rebutted by climatic, edaphic, and even historical facts, and which will arouse much controversy in our country, is due to the fact that this author may have adapted the Köppen classification without discrimination, in his geographic description of America (Schmieder, 1927 and 1946: 707 and 829).

The new moisture regions of De Martonne, although they sensibly improve that which can be obtained with his index of aridity, present some interesting discrepancies in our country if they are related to the natural vegetation.

According to its author (De Martonne, 1941) "in the low latitudes dense forest does not exist where the indices are less than 30; between 30 and 20 we find the savannas with bands of forests. In the high latitudes, the herbaceous formations spread out to replace the forest where the aridity index is less than 25 and the steppe, with extensive thickets, appears when the index is less than 15."

In our country, in the low latitudes we find forest formations with indices that vary between 10 and 20, as in Tucuman and Salta. But in these same latitudes and between the same values of aridity index, the forests and xerophyte thickets of the Parque Chaqueño are ubiquitous. In the middle and high latitudes we find the

hygrophyte forests of the Foresta Valdiviana with indices less than 25, and the Patagonian steppe at indices greater than 15.

The Thornthwaite system of classification of 1931 (figure 7C) has the advantage over that of Köppen of introducing the sub-humid type of climate between the typically humid and the semi-arid type, as a transition climate that is present in its correct place in our Estepa Pampeana. Nevertheless, we must observe that in the northern part of the country there exists within a similar moisture region, the Selva Tucumano-Oranense and the xerophytic forests of the Parque Chaqueño.

Finally, the Thornthwaite system of 1948 (figure 7D) presents itself to us as the most fitted to the distribution of the natural vegetation in our country, but its general considerations, having been explained previously are not repeated here.

REFERENCES CITED

Ackerman, E. A. (1941) "The Köppen Classification of Climates in North America." *Geogr. Rev.*, vol. 31, p. 105–111.

Burgos, Juan J. (1950) *El evapotranspirómetro de Thornthwaite.* Ministero De Asuntos Tecnicos, Serie Agrometeorologia, Pub. No. 2.

Davies, W. (1902) *Climate of the Argentine Republic.* Buenos Aires.

Davies, W. (1910) *Climate of the Argentine Republic.* Buenos Aires.

De Candolle, A. (1855) *Géographie botanique raisonée, ou Exposition des faits principaux et des lois concernant la distribution géographique des plantes de l'époque actualle.* Paris et Genève, 2 vols.

De Candolle, A. (1874) "Constitution dans le regne végétal de groupes physiologiques applicables à la Géographie botanique ancienne et moderne." *Bibliothèque Universelle, Archives de Sci. Phys. et Nat.* vol. 50 (N.S.), p. 5–42.

De Martonne, E. (1926) "Une nouvelle fonction climatologique: l'Indice d'aridité." *La Météorologie,* Oct. 1926, p. 449–458.

De Martonne, E. (1941) "Nouvelle carte mondiale de l'indice d'aridité." *La Météorologie,* Jan. 1941, p. 3–26.

Drude, Oscar (1890) *Handbuch der Pflanzengeographie.* Stuttgart.

Grisebach, A. (1866) "Die Vegetations-Gebiete der Erde, übersichtlich zusammengestellt." *Petermanns Mitt.*, vol. 12, p. 45–53.

Hauman, L., Burkart, A., Parodi, L. R., and Cabrera, A. L. (1947) "La vegetación de la Argentina." *Geografía de la República Argentina,* (GAEA), Buenos Aires, vol. VIII.

Knoche, W., and Borzacov, V. (1947) "Provincias climáticas de la Argentina." *Geografía de la República Argentina,* (GAEA), Buenos Aires, vol. VI, p. 140–174.

Köppen, W. (1884) "Die Wärmezonen der Erde, nach der Dauer der heissen gemässigten und kalten Zeit and nach der Wirkung der Wärme auf die organische Welt betrachtet." *Meteor. Zeitschr.*, vol. 1, p. 215–226.

Köppen, W. (1900) "Versuch einer Klassifikation der Klimate vorzugsweise nach ihren Beziehungen zur Pflanzenwelt." *Geogr. Zeitschr.*, vol. 6, p. 593–611 and 657–679.

Köppen, W. (1923) *Die Klimate der Erde.* Berlin und Leipzig.

Köppen, W. (1931) *Grundriss der Klimakunde.* (2nd edit. of *Die Klimate der Erde.* Berlin und Leipzig.

Köppen, W., and Geiger, R. (1936) *Handbuch der Klimatologie.* Berlin, Bd. II, Te. G, Knoch, K. "Klimakunde von Südamerika," 349 pages.

Penck, Albrecht (1910) "Versuch einer Klimaklassifikation auf physiogeographischer Grundlage." *Sitzungsber. Koningl. Preuss. Akad. der Wiss., Phys.-Math. Klass.*, Berlin, vol. I, p. 236–246.

Russell, R. J. (1926) "Climates of California." *Univ. of Cal. Publications in Geogr.*, vol. 2, no. 4.

Sanderson, M. (1948) "An Experiment to Measure Potential Evapotranspiration." *Canadian Journal of Research*, C, 26, p. 445–454.

Sanderson, M. (1948) "The Climate of Canada According to the New Thornthwaite Classification." *Scientific Agriculture*, vol. 28, p. 501–517.

Schimper, A. F. W. (1898) *Pflanzen-Geographie auf physiologischer Grundlage.* Jena.

Schmieder, O. (1927) "The Pampa.—A Natural or Culturally Induced Grass-land?" *Univ. of Cal. Publications in Geogr.*, vol. 2, no. 8.

Schmieder, O. (1946) *Geografia de America. America del Norte, America Central, America del Sur.* Mexico.

Thornthwaite, C. W. (1931) "The Climates of North America According to a New Classification." *Geogr. Rev.*, vol. 21, p. 633–655.

Thornthwaite, C. W. (1946) "El agua en la agricultura." *Irrigacion en Mexico*, vol. 27, no. 2, p. 19–43.

Thornthwaite, C. W. (1948) "An Approach Toward a Rational Classification of Climate." *Geogr. Rev.*, vol. 38, no. 1, p. 55–94.

Thornthwaite, C. W., and Holzman, B. (1942) *Measurement of Evaporation from Land and Water Surfaces.* U. S. Dept of Agric. Tech. Bull. No. 817.

Van Royen, W. (1927) "The Climatic Regions of North America." *Monthly Weather Review*, vol. 55, p. 315–319.

REVIEWS AND ABSTRACTS OF STUDIES

SWISS IN CALIFORNIA

Maurice E. Perret, *Les Colonies Tessinoises En Californie,* 214 pp., appendices, maps, photographs, bibliography, index. Lausanne: F. Rouge et Cie., 1950.

The present study grew out of a master's thesis prepared at the University of California (Berkeley) where the author spent two years. The thesis, completed in 1942, was the result of extensive investigation of Italian Swiss colonies throughout the state of California. In 1945, Mr. Perret returned to Switzerland and, at intervals, continued research in the canton of Ticino, the homeland of the immigrants to California. The results, embodied in a doctoral dissertation, completed at the University of Lausanne, is a definitive report on the Italian Swiss in California.

The name "Tessinois" and Italian Swiss are near equivalents designating persons born in Switzerland who speak Italian, applied also to descendants of such persons. The homeland of the Tessinois is the canton Ticino (Tessin) which lies south of the Alpine crest —here the Lepontine Alps—in the drainage basin of the Ticino River. The lower areas of the canton encircle the north shore of Lake Maggiore adjacent to Locarno, and much of the Lake Lugano littoral. Southward stretches the Plain of Lombardy. Ticino has always been a poor canton; economic opportunities are not wanting in the southern districts, but in the high northern valleys life is difficult at best, and excess population seeks employment beyond the canton in Europe and in other continents.

Mr. Perret presents his study *Les Colonies Tessinoises En Californie* in three parts. Part I, "The Italian Swiss Immigration into California," analyzes the origins of the emigration abroad and the movements into California; Part II surveys California and the state's constituent regions, and discusses the activities of the Italian Swiss in each major geographic region from the time of their arrival in California until 1942. Part III summarizes the results of the migration: the importance to California and the consequences for Ticino.

Emigration is endemic in the canton of Ticino. It is periodic in the southern, better-endowed districts, but largely permanent in the mountain valleys such as Val Maggia and Val Leventina. As early as 1834 certain tradesmen emigrated to New York, but not until the 1850's did a strong current set toward the New World. Argentina drew migrants from the southern communes, while California attracted emigrants from the northern valleys. The draining off of excess population proved a blessing to the impoverished canton.

The intensity of migration fluctuated with changing economic and political conditions in Switzerland and the United States. It was strong in the middle fifties, weak in the mid-seventies and then picked up in the eighties during the California boom. The earthquake of 1906 checked immigration into California as did the first world war. Finally U. S. immigration laws effected permanent restrictions. The year 1930 marked the apogee of Swiss colonies in California. Conservatively estimated, there were 20,000 Italian Swiss and their descendants living in the state that year.

The Italian Swiss came in groups and, generally speaking, remained in groups. They formed so-called colonies dispersed on farms rather than village aggregations. The most pronounced concentrations developed in the California Coast Ranges: in Marin and Sonoma Counties near San Francisco Bay, in Humboldt County farther north, and in Santa Cruz, Monterey, and San Luis Obispo Counties in the south. Dairy farming is favored in this whole region. Marine terraces and alluvial plains provide natural pasturage, the climate is cool and foggy and markets for dairy products are close by. Moreover, dairying is a traditional occupation for many of the Italian Swiss. In California they became dairy farmers and achieved notable success.

Although the Italian Swiss in California are predominantly rural dwellers, they settled in many of the cities along the coast and in the longitudinal valleys of the Eel, Russian and Salinas rivers. Since the turn of the century groups have moved into the Great Valley and have settled in farming districts from Sacramento to Merced. As in all the other major centers of dairying, the Italian Swiss have organized cooperatives and industrial enterprises such as creameries, cheese factories and plants for the manufacture of casein, and condensed and powdered milk.

The city of San Francisco serves as social and cultural focus, and in the Bay Area one finds a larger percentage of the Tessinois in the professions. In San Francisco is published "L'Elvezia," a Swiss journal in the Italian language, one which provides a significant bond between émigrés and their homeland.

In other regions of California the Italian Swiss are scattered. Only a few remain in the Sierra Nevada where large numbers were engaged in mining during the Gold Rush days. Some still hold large acreages in Sierra Valley. Southern California has never attracted the Tessinois owing in part to the warm dry climate and doubtless to the industrialized nature of dairying in the Los Angeles area.

The consequences of the migration are far-reaching. Although the Italian Swiss comprise only a small segment of California's population, they have made a definite contribution to the state's economy. As a group they are thrifty and industrious, and their initiative has advanced the dairy industry. In Ticino, however, the emigration of many young men drained off strong, active elements of the population and created an abnormal demographic distribution. The economic bases were undermined and some communities largely deserted. On the other hand, money returned to the homeland in bank deposits, taxes, and gifts redounded to the benefit of Ticino as well as of Switzerland. Recently the door to unlimited immigration was closed by the United States, yet conditions in Ticino are far from hopeless, for today industry contributes to the canton's economy.

Other studies of Italian Swiss occupance in California have been made, but in no single study has the whole problem been completely analyzed. The problem begun by the author in California was carried to the source area in Switzerland. Antecedent problems were correlated with the results already studied. The product is an excellent definitive report on the Italian Swiss in California which relates significant data derived from two widely separated areas.

Perret essays a quantitative as well as qualitative analysis in his study of source areas and the strength of Tessinois emigration, especially as related to certain districts as the Val Maggia. He goes a step further in attempting to correlate area of origin and destination of particular groups of migrants. However, in view of the incomplete nature of both Swiss and American census data pertinent to the subject and the fact that Swiss and United States statistics are not always contemporaneous, such coordination is difficult to establish.

In Part II the author's description of the major regions of California and the conditions which drew colonists and supported their activities there is good geographic analysis, but as a whole somewhat repetitive. Condensation would improve this section.

Statements are well documented throughout the study and the bibliography, particularly the Swiss sources cited, is a distinct contribution. The two appendices indicate the thoroughness of Mr. Perret's work. The first lists over 1400 Italian Swiss family names in California and gives the communes of origin in Switzerland; the second, a classified list of informants in California and in Switzerland. Twenty maps and diagrams accompany the text; six of them are folded. The latter are adequate but lack clarity, especially figures 3 and 4 whose symbols are blurred and therefore difficult to read. American readers would welcome the inclusion of additional maps showing the general situation of Ticino in relation to other Swiss cantons and to Italy, and the relief features of the canton under study. Six photographs, well selected and well placed, illustrate the text.

There are aspects of Mr. Perret's study which should interest the historian and sociologist as well as the geographer. Parts I and III are concerned with the causes and consequences of the migration of a particular group of people, and of the economic and social forces which set these people in motion. The Italian Swiss, it is true, comprised only a small fraction of the migrating hordes that left Europe in the last half of the nineteenth and the first quarter of the twentieth century, yet their migration had significant consequences.

RUTH E. BAUGH
University of California
Los Angeles

ESSAYS IN GEOGRAPHY

L. Dudley Stamp and S. W. Woolridge, editors, *London Essays in Geography*. Published for the London School of Economics and Political Science by the Harvard University Press, Cambridge, 1951.

The seventeen essays in this collection were assembled by colleagues and students of the late Llewellyn Rodwell Jones in order to honour the memory of a distinguished figure in British geography; but, in addition to fulfilling their immediate purpose, they provide the non-British reader with a revealing glimpse into the current state of mind of the profession in Great Britain. Although all of the contributors have been associated with Joint School of Geography at King's College and the London School of Economics, there is no lack of diversity in interests and outlook—a fact reflecting credit on the Joint School and Professor Jones, its director for a score of years—and there is a maturity of scholarly technique and a deep curiosiy about the internal and external frontiers of geography in most of these papers that turn this volume into a notable benchmark in the development of the science.

Excepting Dr. Stamp's concise introductory account of the history of the Joint School, the *London Essays* readily divide themselves into two quite distinct categories. The first, consisting of substantive articles, contains two on land planning, four on British economic history, three on transport, two on other aspects of economic geography, and two on the historical geography of areas outside the British Isles. Some of these papers possess a good amount of intrinsic interest, as, for example, F. Grave Morris' comparison of the evolution of rural settlement patterns in Britain and New England, H. J. Wood's summary of the ancient world's knowledge of Africa, or Harrison-Church's description of Trans-Saharan railroad projects, and they can be read with pleasure by anyone. But one wonders whether it is good editorial policy in collections intended for the entire geographic public to include articles of so highly precious a character that no one except other specialists can hope to derive any profit from them. I have in mind the learned items on aspects of the economic history of various regions within Great Britain which appear to the outsider to meet high standards of scholarship. The internal validity of their minute facts and conclusions is, however, difficult to judge, and even harder to comprehend is the way in which they relate and contribute toward the larger pattern of British geography, for the connections are not made explicit by the authors.

The second group of essays are those of a methodological nature; and two pieces on geomorphological theory, two on climatological classification, and Kimble's paper on regionalism can be numbered among them. They are characterized by an incisiveness of thought and a skill in exposition that makes them worthy of repeated study. George H. T. Kimble's felicitously phrased "The Inadequacy of the Regional Concept" is a classic document that should be required reading for all geographers and a good many sociologists. He has had the moral courage to direct a frontal assault on what he considers a scientific will-o'-the-wisp and to attempt to end once and for all the absurdity of trying "to put boundaries that do not exist around areas that do not matter." Justice cannot be done to his views in a short note, but it should be indicated that unless an adequate rebuttal is forthcoming Kimble's paper will stand as the closing salvo in one of the major skirmishes in the unhappily continuing campaign to put neat fences around the geographer's field; it should, at the very least, raise some sort of furor.

The geomorphological papers—Woolridge's on the role and relations of geomorphology and Linton's on the delimitation of morphological regions—are almost equally provocative. Woodridge strives with great persuasiveness to provide geomorphology with its proper place in the geographic sun and to redeem it from its present status as an unwanted orphan in both the geographic and geological households and give it the same secure position within geography as a kind of "historical geography of the physical landscape" as cultural historical geography has already attained. Linton attempts in his contribution to synthesize the methodological successes of both American and European physiographers in plotting geomorphological regions—the former on a macroscopic and the latter on a microscopic scale—into one single hierarchy of regions, ranging from the continent down through several stages to the final irreducible elements of slope and

flat. He accompanies his argument with illustrations from his work in mapping morphological regions of differing rank in a portion of Scotland. Kenneth Hare's paper on climatic classification is a lucid, succinct resume of the various Köppen and Thornthwaite systems that will be of great value to both the beginning and advanced student. The text and graphs of P. R. Crowe's "Rainfall Regime in the South-eastern United States," which is an illustrative attempt to discover a general system for delimiting rainfall regions, are virtually unintelligible to the uninitiated who have not followed Crowe's previous writings on the topic.

The difficulty of framing general remarks about scientific miscellanies should be obvious, but the following thoughts may occur to other readers. As in much of their other scholarly writing, the British here again demonstrate their adeptness in producing scientific prose that is both lucid and elegant. There are some lapses in these essays, but one could wish for all geographical writing the same seemingly effortless verbal competence found among the best examples in this volume. A reading of the *London Essays* also leads one to wonder whether the time is not ripe for American geographers to emulate the popular European practise of issuing memorial volumes and *festschriften*, for, as in Britain, the profession has here matured to the point where the self-criticism implicit in such ventures is a challenge that can be faced with some confidence (and there is also the consideration that the productivity of the scholar has begun to exceed the capacity of regular channels of publication). If any serious reservation can be made about the kind of work represented in this collection, it might be the noting of the omission of any article based directly on field observations. The great bulk of these papers are entirely library studies, and the remainder are only indirectly derived from actual field experience, surely not too representative on account in this one respect of so unsedentary an occupation as geography has proved to be to most of its practitioners.

WILBUR ZELINSKY
University of Georgia

AN AID TO RESEARCH

Richard M. Pearl, *Guide to Geologic Literature*. 239 pp., Index. McGraw-Hill Book Co., New York, 1951. $3.75.

As the title indicates, this is a guidebook to the literature on geology. It serves well the geographer, geologist, cartographer, and reference librarian. The book is divided into three parts—introduction, library facilities, and the kinds of geologic literature. The information presented is cross-referenced throughout the book. A world wide Directory of 119 scientific publishers and services provides a selected list for the searcher. The Index is 27 pages in length.

A reference librarian will welcome this book as a needed guide in another field of science. It may mean that geographers and geologists will be able to approach their problems of literary research with much more understanding. For instance, Pearl explains the portions of the Dewey Decimal system and the Library of Congress system of classification of books that deal with geology. In order that the scientist need not remain too dependent upon his librarian, the Library of Congress card cataloguing system is illustrated and interpreted. The classic indexes of geologic literature are recorded, and author index and subject index problems simplified. Of the 25 libraries in the United States listed with the most important collections of geologic publications, 17 are in university libraries. The remainder are in private or government libraries; no college libraries are listed. Twenty-seven library collections most important for geographic research are enumerated. Services on photoprinting, microfilming, and on translations are clarified.

The remaining 80 per cent of the book (13 chapters) is concerned with index guides and bibliographies, abstracts, periodicals, United States government documents, organization bulletins, state bulletins, county and city bulletins, bulletins of foreign countries, books, newspapers, theses, unpublished manuscripts, and maps. American librarians have indexed and compiled bibliographies among their own library holdings. Fifteen libraries have special indexes represented under the headings Geology, Geography, Paleobotany, and Mining. Published bibliographies include those in general geology, seismology, geography, mining, and general science and technology, including geology. Other sciences with bib-

liographies on subjects related to geology are chemistry, physics, and agriculture.

A discussion on the value of abstracts as guides to the literature introduces the subject of abstract journals in general geology, economic geology, geophysics, ground water, mineralogy, mining, petroleum, and coal, and in chemistry, physics, and engineering. So important is the periodical a medium of expression in geology that the data needed for success in research are stressed. The periodicals are listed in many sources, such as general lists, library lists, union lists, and index guides.

United States government documents pertaining to geology are found under their respective Departments: Interior, Bureau of Mines, Agriculture, Commerce, and in Independent Offices and Quasi-Official Agencies. A Directory of state geologic surveys tabulates all states with a survey of some nature, except Delaware, Massachusetts, and Utah (although Massachusetts has a cooperative project between the Massachusetts Department of Public Works and the U. S. Geoolgical Survey). There is a Directory of 42 state bureaus of mines. County and city publications are included, although relatively insignificant. Concluding a chapter on foreign countries is a Directory of 73 geologic surveys in the world outside the United States. Canada, Great Britain, the British Colonies, Central and South America, India and Pakistan, and Japan are treated more in detail than other countries. A miscellaneous category exists for publications that "do not belong in the other chapters of this book." Pearl pigeonholes these into a chapter on books. He discusses review series, reference books (textbooks, handbooks, tables, yearbooks, dictionaries, and encyclopedias), book reviews, book abstracts, and lists of new books, selected books, and older books. Scientific material appears in newspapers when it has current news value, but it may be years before it is published in a scientific journal.

The last chapter, on maps, is highly useful for cartographers, as for geographers and geologists. United States government maps are issued by the Geological Survey as indexes and catalogues, and by other agencies, such as the Bureau of Plant Industry, Soils, and Agricultural Engineering, the Army Map Service, Coast and Geodetic Survey, Bureau of Land Management, the Forest Service, and the National Park Service. Organization Maps include those published by the Geological Society of America, the American Association of Petroleum Geologists, the American Geographical Society, and the National Geographic Society. Catalogues of the maps published by the Geological Survey of Canada are listed, as well as those of 5 other countries. Commercial Maps and Aerial Photographic Maps complete the discussion.

Despite the fact that the advance of geology as a science is slow, this book will help the researcher hasten its progress. The best judge of such a book as this is its usage. It will prove invaluable to the geographer probing into geology, and to new researchers and other scientists working for the first time in geology. Such a book has long been needed —a guide, which will point the way towards sound research.

SIDNEY E. WHITE
Syracuse University